Poles 'n' Wires

User Manual

Quick and Simple

Power Line Design Software

Create a Refined Line Design...

...in Minimal Time!

PowerMation

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REVISION STATUS

The following table details the revision status of each section of this document:

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0	9
1	7
2	6
3	8
4	7
5	5
6	5
7	10
8	5
9	8
10	3
11	2
12	2
13	3
14	3
15	1
16	1
17	2

1. INTRODUCTION

1.1 Function

Poles 'n' Wires is a simple yet powerful tool for designers of overhead power lines and others who may need to check:

- clearance heights of overhead wires,
- mechanical loads applied to poles and support structures by attached conductors,
- wood pole strength,
- conductor ratings, reactance and spacing requirements.

With *Poles 'n' Wires*, you do not need to be an expert to perform these calculations!

1.2 Module Overview

Conductor Sag-Tension-Temperature Calculator

Enter temperature, span length and stinging tension (or sag) of the conductor to determine sag (or stringing tension), actual tension under 'Wind' and 'No Wind' conditions, and mid-span 'blowout' of the conductor.

Stringing Table Generator

Associated with the Sag-Tension-Temperature Calculator is a Stringing Table Generator that allows you to produce tables showing sag, tension or blowout for a range of span lengths and temperatures for a nominated conductor.

Line Profiler

Enter survey data for the ground line, place poles, attach circuits and then let the program draw the profile. You can check that ground clearances are adequate and that inter-circuit clearances are maintained even when the top circuit is at its maximum design temperature. You can also check for uplift conditions on poles.

Pole Tip Load Calculator

Determine the resultant load on a pole due to the forces applied by the attached conductors or cables. Enter details of the attached conductors, and the module calculates the resultant equivalent tip load and applied bending moment for 'Wind' and 'No Wind' conditions.

Pole Strength Calculator

Determine the tip load capacity or bending moment capacity of the wood pole. Enter details of the pole at its base, eg its diameter, timber species, measurements of any internal hollows.

Conductor Library

Use the large existing database of conductors and cables, or add to it as you require.

MES/RS Calculator

Determine the Mean Equivalent Span, or Ruling Span, for a strain section of mains. This is an important element in determining sags and tensions in new lines when span lengths within the section vary significantly.

Sag Calculator

Calculate the sag in a span from conductor height measurements or from times for conductor wave returns or swing.

Conductor Ratings

Calculate the current rating of a bare conductor under different atmospheric conditions.

Line Reactance

Calculate the inductance, capacitance and characteristic impedance of a line given conductor type and inter-phase spacing.

Conductor Spacing

Calculate the maximum allowable sag in a span, if mid-span clashing is to be avoided, given voltage and conductor spacing at supporting poles.

1.3 General

Poles 'n' Wires operates on a Citrix Server.

- Please contact software@ipowermation.com for more information.

Mutliple Instances of Poles 'n' Wires can now be opened.

- This is useful if you need to, for example, be working on a profile and want to examine tip loads produced at the same time.
- Please note: It is important that the user exits properly from each instance of Poles 'n' Wires.

1.4 Method of Analysis

The structural calculation method used by the software generally follows the method outlined in the Electricity Supply Association of Australia (ESAA) document HB C(b)1 “Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines” for working stress design. The software accommodates methods outlined in 1991, 1999 and 2003 editions of this document.

The software models the catenary as a hyperbola. The MES/RS calculation method is based on level-span behaviour.

The program makes certain assumptions and uses various approximations in its modelling of power lines. Although these generally accord with industry practice, the user should verify that the conductor data and results produced by the program are suitable for the intended application, running test cases as necessary. PowerMation takes no responsibility for the accuracy of the results produced by it's software or for any circumstance or circumstances resulting directly or indirectly by the application of those results.

1.5 Computer Requirements

The program is designed to operate on *IBM-PC* compatible machines with a *Windows* operating system (*Windows 95* or later).

A minimum of 10 Mb of hard disk space is required to load the core software, plus another 12 Mb for the help text files. Another 10 Mb should be allowed for this manual in electronic form.

Reports are generated in various formats including as DXF and PDF files and some reports are printed directly to the default printer.

2. INSTALLATION

2.1 Pre-installation Checks

Before starting the installation, check that:

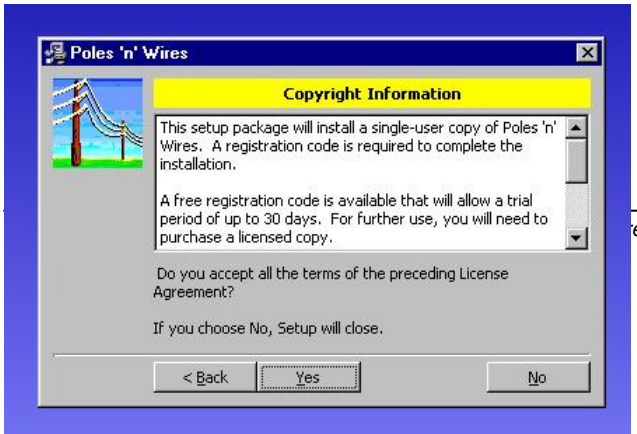
- your computer meets the minimum system requirements in terms of adequate disk space to load the program
- you have read and accepted the End User Licence Agreement (see card enclosed).

Ideally, your computer should have Internet or email access so that you can use the automatic on-line registration feature built into the software. (If not, after the first stage of the installation you will need to contact PowerMation by telephone or facsimile to obtain your customised security identification key, which is required to complete the installation.)

2.2 Running the Set Up Program

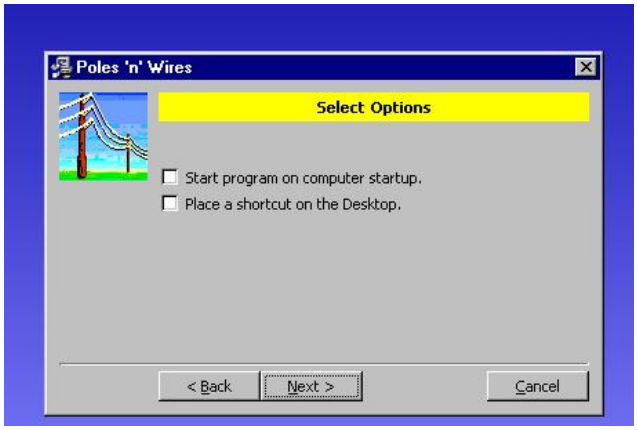
Insert the *Poles 'n' Wires* installation CD-ROM into the computer's CD drive. The installation program will start up automatically. The screen shown below will appear.

Click on the *Next* button to proceed.



Carefully read the License Agreement

(A full End User License Agreement is located on the CD). If you accept all the terms of use of the software, click on Yes to proceed with the installation. Otherwise click on *No* to exit Setup.



Check the top box if *Poles 'n' Wires* is a program you will use frequently and you would like included in the start up menu.

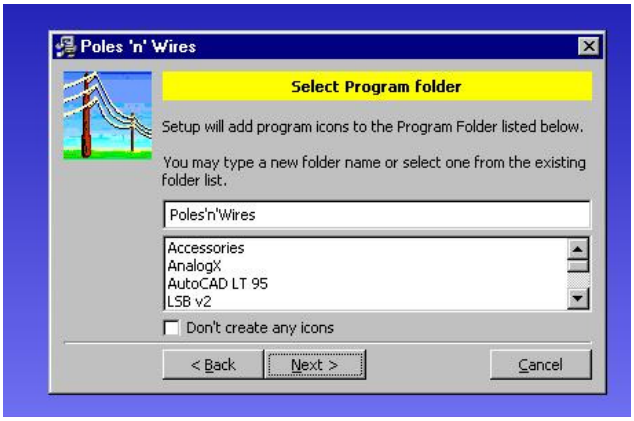
Check the bottom box if you would like a shortcut to *Poles 'n' Wires* installed on your *Windows* desktop.

Click on *Next* to continue.

The default path for installation is *C:/Program Files/Poles'n'Wires* or *C:/Program Files/PowerMation/ Poles'n'Wires.*

You have the option to select an alternative folder or directory in which to install the software.

Click on *Next* to continue.



The default folder in which the *Poles 'n' Wires* shortcut is installed is *Poles 'n' Wires* or *PowerMation/Poles 'n' Wires*.

You may nominate any other existing folder or program group on your computer.

Click on *Next* to continue.

Your settings are summarised for

checking.

Click on *Next* to continue.

Click on *Finish* to complete the installation.

2.3 Starting Poles 'n' Wires Running

Once the Set-up is complete, activate the program by either:

- double-clicking on the *Poles 'n' Wires* shortcut
- using the Windows Menus – typically *Start – Programs – Poles 'n' Wires – Poles 'n' Wires*
- using *Windows Explorer* (or alike) to locate the *Poles 'n' Wires* program folder, and then double clicking on the program file *PolesnWires.exe*.

A 'splash' screen will appear and remain active for a second or two, before the main screen appears. You may click on the splash screen to move to the main screen more quickly.

2.4 E-mail Registration

At this stage, the program has limited life and/or limited functionality – just like a demonstration version. Click on the *Help* menu, *Register* to apply for your customised security identification key, which is required to complete the installation and obtain full program functionality. The program will take you to the on-line registration page of the PowerMation web site. Complete the form provided, giving your contact details, and then click on *Submit*.

If you have e-mail facilities on the computer, click on the Register (e-mail) button and an e-mail will be generated. Complete your contact details and send the e-mail to the address as given.

Once you have done this, exit *Poles 'n' Wires* until your return e-mail from PowerMation is received. (There may be two or three working days turnaround for this transaction.) *PowerMation* will officially register your installation and respond by supplying you with your security code in an e-mailed reply.

Note that if you do not install the security key within 30 days of program installation, the demonstration copy will expire.

2.5 Installing the Registration Code

After processing your Registration, PowerMation will send you an email with your personalised security code. There will be instructions in the email explaining how to install the code.

Your security key is specific to your computer. Should you wish to reinstall *Poles 'n' Wires* on a different computer, or reinstall it on your original computer, eg after a hard drive crash, you will need to apply to PowerMation for a new security key.

2.6 Registration via Facsimile

If you do not have e-mail facilities, click on the *Print Registration* button to print out your registration details and send them to PowerMation by facsimile. A security key code will be faxed back to you for entry into the computer to activate the program as a fully-fledged registered copy.

2.7 Updating Poles ‘n’ Wires to a Later Version

To manually update your software to the latest version via the Internet, click on the Help menu on the main program toolbar, then on Autodownload.

Poles ‘n’ Wires is equipped with an Auto Update facility. To turn on this feature, click on the *Options* menu on the main screen and select *Options Settings* (alternatively, Click on the *Options* button or *Options* menu in any Module and navigate to the *General Options* tab), then select *Automatically check for updates.*
Once selected, every time *Poles ‘n’ Wires* is started, a check will be made to see if there are any updates available. If so, they will automatically be downloaded and the user will be informed via a message box (Explaining that the *Update* will be installed next time the program is started).

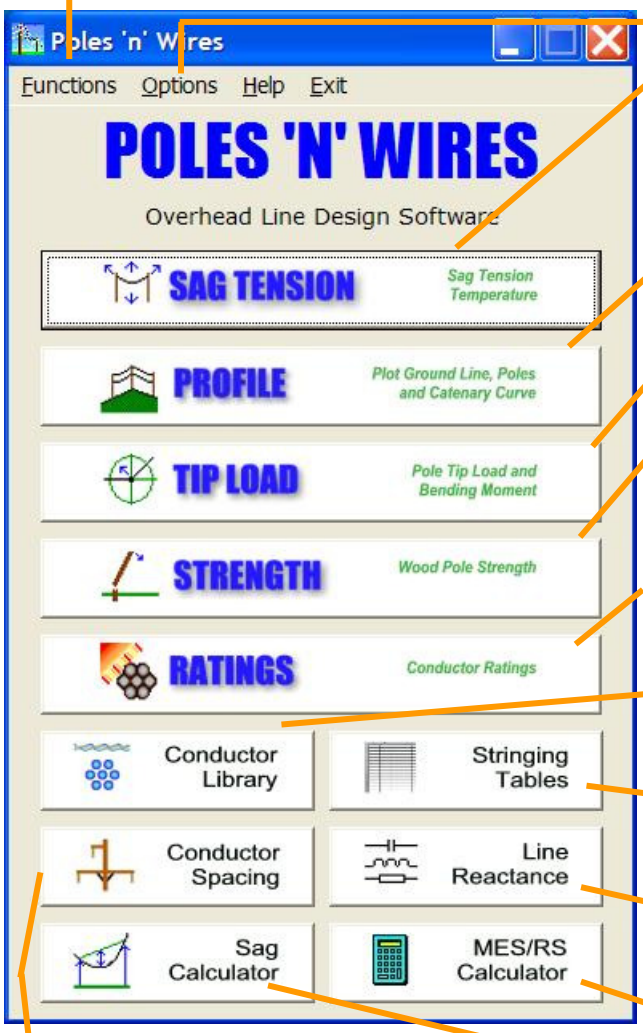
Note: These options are only available to users that register for ongoing support and updates.

3. GETTING STARTED

3.1 MAIN SCREEN

Having completed the installation and registration, you are now ready to use the various features of the software. Start the program running by double clicking on the *Poles 'n' Wires* icon.

The main *Poles 'n' Wires* screen appears, as shown. This screen includes buttons for activating the various modules, as well as a menu bar providing access to the *Options* control, on-line help and various supplementary functions.



Functions Access all functions through menus.

Options Adjust program settings, Save/Load program settings and Import/Export Working Set data

Conductor Sag-Tension-Temperature Calculator This is the calculating 'heart' of the software. It models the behaviour of the nominated conductor given the temperature, span length and stringing tension (or sag). It calculates tensions under 'No Wind' and 'Wind' conditions.

Line Profiler Plots the profile of the powerline circuits, poles and ground line.

Pole Tip Load Calculator Finds the resultant load on a pole due to the tension of attached conductors, pole-mounted plant and wind forces.

Pole Strength Calculator Determine the tip load and bending moment capacity of a wood pole given ground line measurements and details of the material.

Conductor Ratings A heat-balance program to determine the current rating of various conductors according to atmospheric conditions and conductor operating temperatures.

Conductor Library Database of conductors and their parameters, which the user can add to or modify as required.

Stringing Table Generator Similar to the Sag-Tension-Temperature module, but tabulates results for a range of span lengths and temperatures.

Line Reactance Determine the inductance, capacitance and characteristic impedance of bare conductors according to line geometry.

MES/RS Calculator Finds the mean equivalent span, or ruling span, for a strain section.

Sag Calculator Calculate the sag in a conductor span based upon height measurements or wave/swing times.

Conductor Spacing Determine the maximum sag that can be allowed in a span given conductor spacing at supports if mid-span clashing is to be avoided.

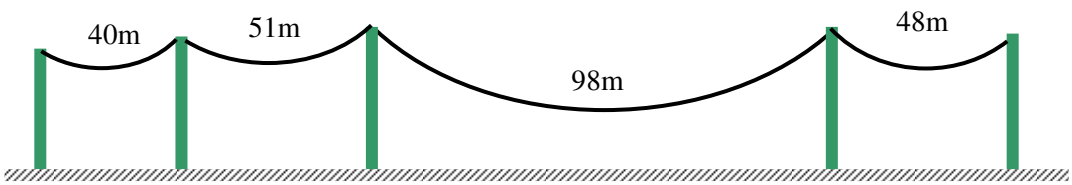
3.2 INTRODUCING THE MES/RS CALCULATOR

Technical Note

The Mean Equivalent Span (MES) or Ruling Span (RS) is a theoretical 'average' span length that approximates the behaviour of spans within a strain section. Larger spans tend to dominate in the calculation. MES/RS becomes important in strain sections comprising varying span lengths when determining sag at other than the standard temperature.

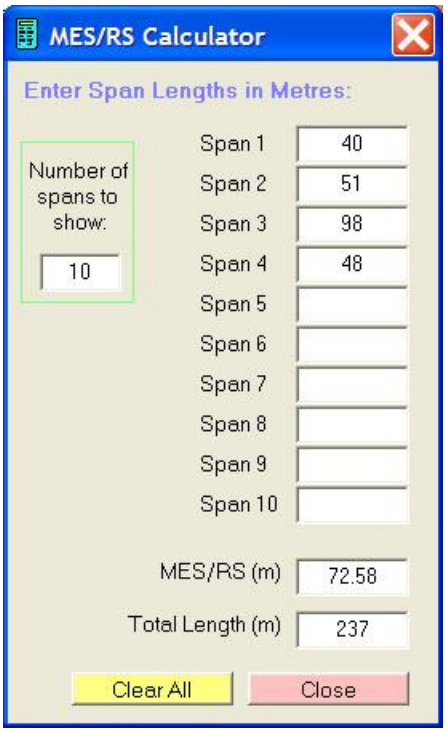
Example

A strain section of mains has 4 spans between the strain (shackle) points at each end. The span lengths are as shown in the diagram below.



Calculate the MES or Ruling Span of the strain section.

Activate the MES/RS calculator, and enter the span lengths into the fields as shown below. The result will automatically be calculated and displayed in the MES/RS field near the base of the form. Total length is also shown for convenience.

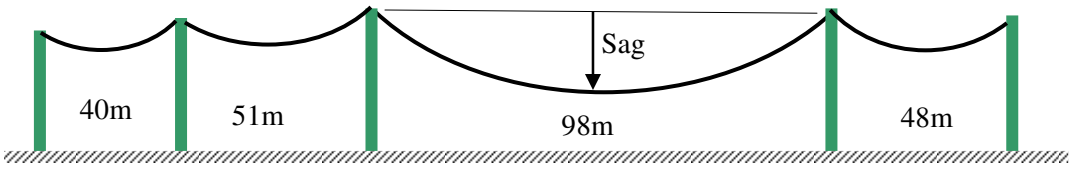


3.3 INTRODUCING THE SAG-TENSION-TEMPERATURE MODULE

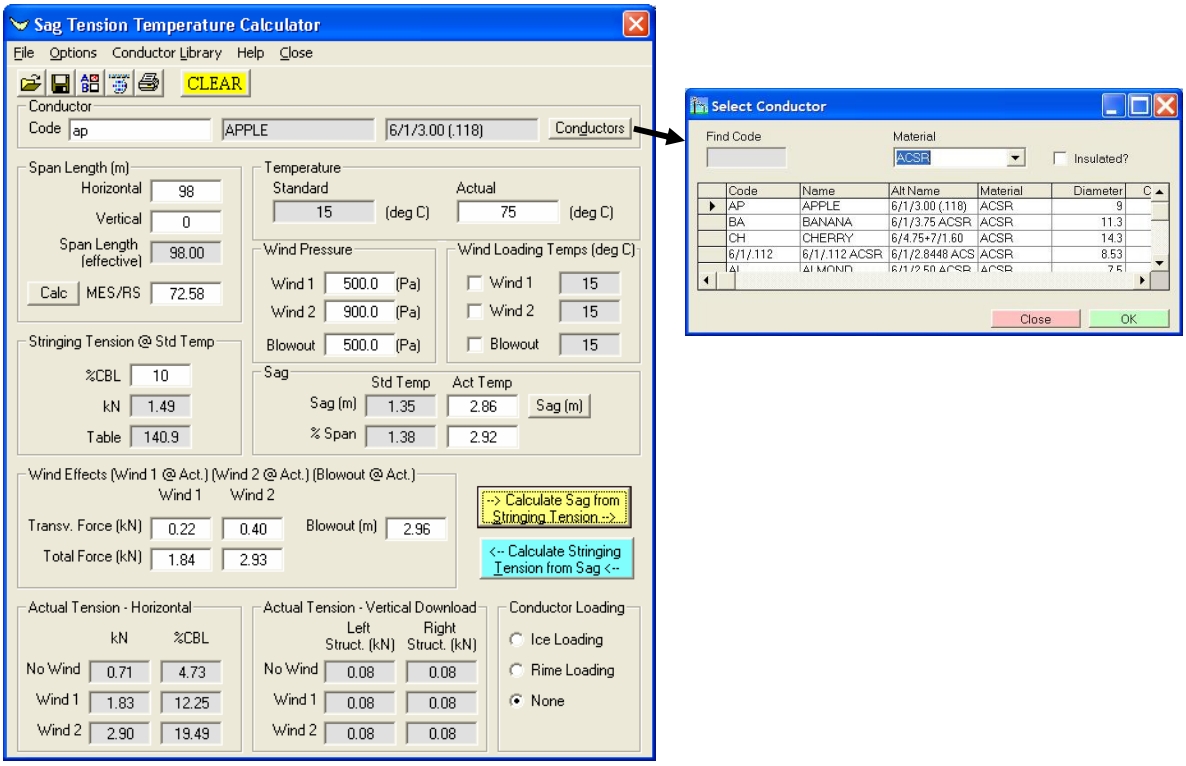
Example 1

For the section of mains shown in section 3.2 on the previous page, it is necessary to calculate the worst-case sag in the large 98m span, when the line is at a maximum design temperature of 75°C.

The conductor is APPLE (6/1/3.00 ACSR aluminium conductor steel reinforced). It is strung at a tension of 10% of CBL (conductor breaking load, or ultimate tensile strength[UTS]), at the standard temperature of 15°C.



Activate the *Sag-Tension-Temperature module*, bringing up the form shown below.



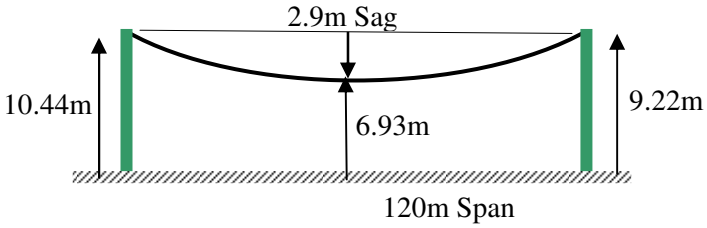
1. If you know the conductor code, type this into the field at the top left of the form. In this case the conductor code is 'AP'. However, if you are uncertain as to the conductor code, click on the 'Conductor' button. This will bring up the form shown above on the right. Select conductor type 'ACSR' from the conductor type drop-down menu. ('ACSR2' is used for conductors with a high proportion of steel.) The conductor grid will display all the ACSR conductors within the database. Click on the line for APPLE - code 'AP'.

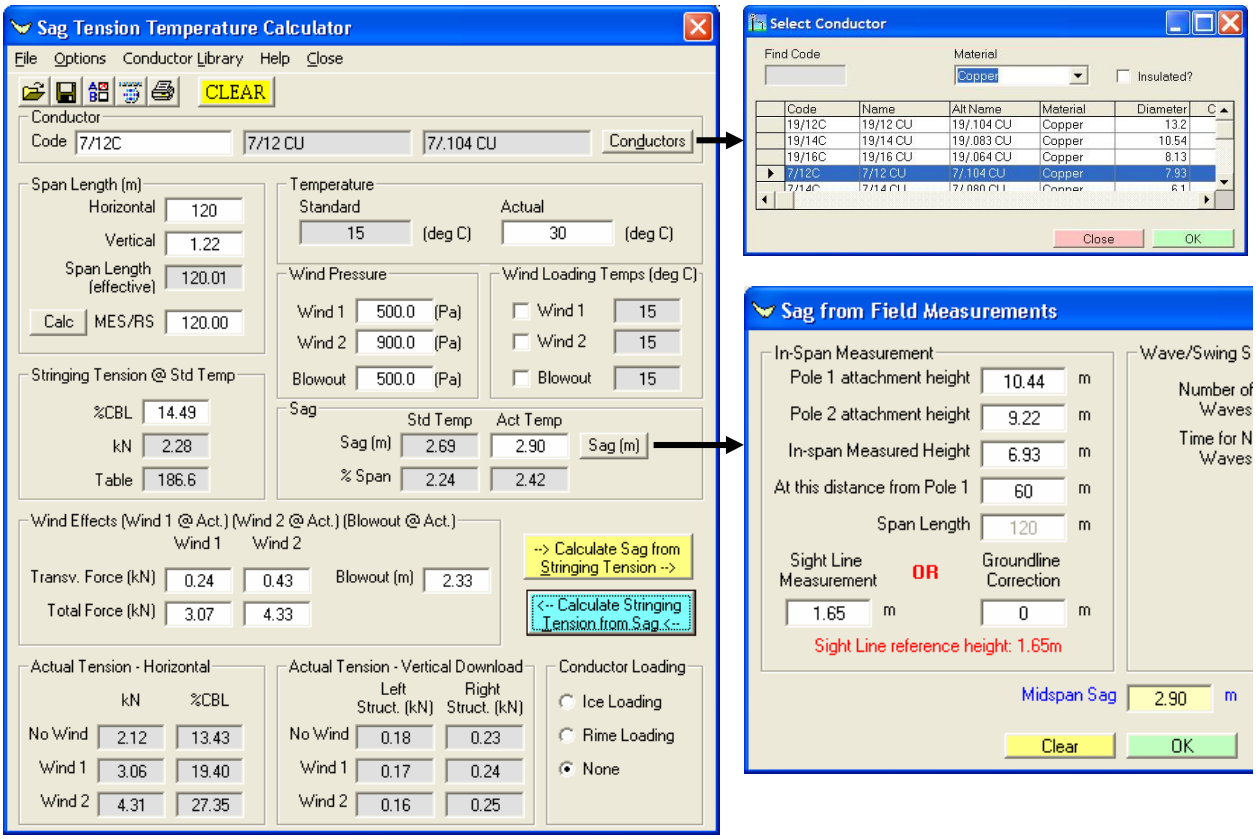
2. Now enter the span length of 98m and then the MES/RS of 72.58m, as shown.
3. Enter the actual conductor temperature of 75°C.
4. Enter a stringing tension of 10% CBL.
5. Click the ***Calculate Sag from Stringing Tension*** button.
6. You should arrive at the result of 2.86m sag. (*Your results may differ slightly if your Options have different settings from those used here.*)

Example 2

A 120m span of 7/12 (7/.104") copper 11kV mains has a measured sag of 2.9m (based upon measurements of conductor height as shown below) when the line is at a temperature of 30°C.

To what tension are the mains strung? What is the actual tension in the mains at 30°C, and what is the blowout in the span under wind conditions?





Enter data into the *Sag-Tension-Temperature* module, as shown below.

1. Enter the conductor code '7/12C', if known. Alternatively click on the 'Conductor' button and select conductor type 'Copper' from the conductor type drop-down menu. The conductor grid will display all the Copper conductors within the database. Click on the line for code '7/12C'.
2. Now enter the span length of 120m. The MES/RS will also default to 120m.
3. Enter the actual conductor temperature of 30°C.
4. Enter a Sag of 2.9m, if already calculated. Alternatively, click on the 'Sag' button to calculate sag based upon the conductor height measurements. This will activate the 'Sag from Field Measurements' form. Enter the conductor heights at each end of the span and mid-span (*In-span Measured Height*). Since the ground is assumed to be level, it is not necessary to enter sight line or ground line correction details. The sag will be calculated automatically from the measurements entered.
5. Hit the ***Calculate Stringing Tension from Sag*** button.
6. The stringing tension is 14.49% of CBL.
7. The actual tensions under *No Wind*, *Wind 1 and Wind 2* conditions are 2.12kN, 3.06kN and 4.31kN per conductor. The blowout is 2.33m.

   Your results may differ slightly if your Options or Conductor Data have different settings from those used here.

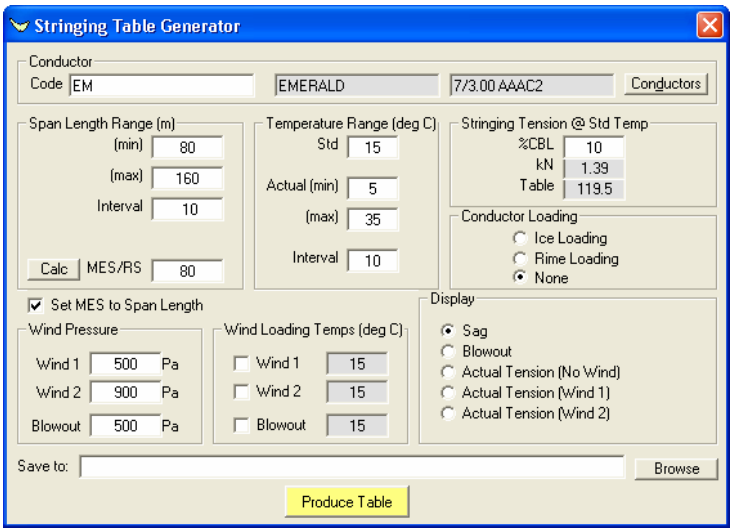
3.4 INTRODUCING THE STRINGING TABLE GENERATOR MODULE

Example

> Generate a set of sag tables for the conductor EMERALD (7/3.00 AAAC) strung at 10% of CBL (conductor/calculated breaking load). Tabulate for a range of spans between 80m and 160m at 10m intervals. For each case, take the MES/RS to be the same as the span length. Consider a range of temperatures from 5°C to 35°C in intervals of 10°C. The standard stringing temperature is 15°C.

Activate the Stringing Table Generator module, bringing up the form shown below.

This is similar to use to the Sag-Tension-Temperature module discussed in the previous section, except that it allows for a range of span lengths and temperatures, and exports a table of results in Microsoft *Excel* format rather than a single output.



1. Select the conductor by entering the conductor code 'EM', or by clicking on the *Conductor* button and searching through the bare AAAC conductors. (Refer section 3.3.)

Note that sag results for a given stringing tension in percent CBL will be similar for all bare conductors made of the same material.

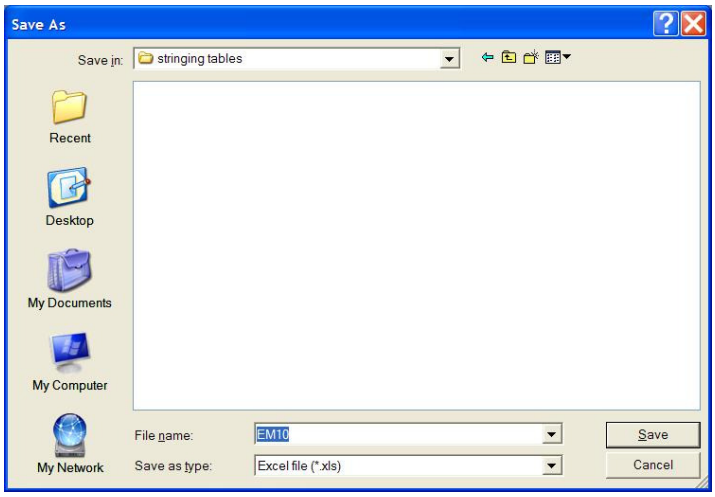
2. For span length, enter 80 as the minimum, 160 as the maximum, and an interval of 10. Since we wish to have MES/RS track the span length, check the box on the right side of the screen to make MES/RS equal to span length.

3. For temperature, set up a range between 5 and 35 with an interval of 10.

4. For stringing tension, enter 10%CBL.

5. Check the *Calculate Sag* button.

6. Now we need to specify the name of the spreadsheet file in which to save the results. To do this, click on the *Browse* button and select the folder and enter file name.



Select a folder in which to locate the file, and enter the file name – something meaningful – in this case 'EM10'. The extension '.xls' is added automatically.

Click on the *Save* button.

The full path name of the file is inserted in the main Stringing Table Generator form.

7. Now click on the *Produce Table* button. This generates the *Excel* file in the required folder.

8. Double click on the spreadsheet file 'EM10.xls' to open it with Microsoft Excel. When opened, the spreadsheet appears as shown below.

	A	B	C	D	E
1	**Stringing Table for EM (EMERALD) (MES/RS equal to Span Length). %CBL: 10.0, Std Temp: 15**				
2	**Displaying Sag (m)**				
3	Created by Poles 'n' Wires (c) PowerMation on 21/05/2007. Serial No. xxxxxx				
4					
5		**Temperature**			
6	**Span Length (m)**	**5**	**15**	**25**	**35**
7	**80**	0.60	0.76	0.95	1.14
8	**90**	0.78	0.97	1.17	1.37
9	**100**	0.98	1.19	1.41	1.63
10	**110**	1.22	1.45	1.68	1.91
11	**120**	1.47	1.72	1.97	2.20
12	**130**	1.76	2.02	2.28	2.52
13	**140**	2.07	2.34	2.61	2.86
14	**150**	2.40	2.69	2.96	3.23
15	**160**	2.77	3.06	3.34	3.61

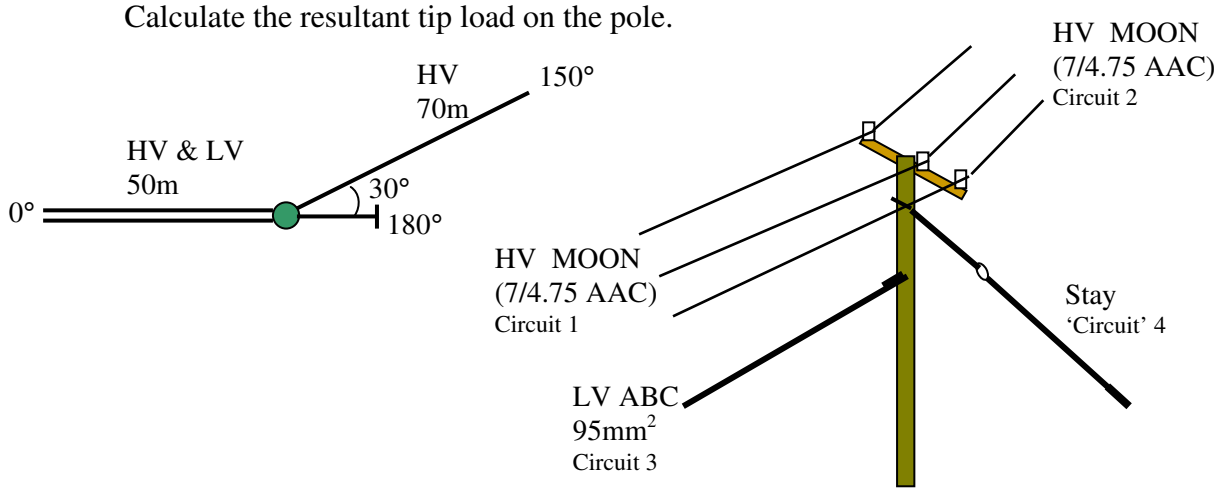
You may then manipulate and format the stringing table as a spreadsheet or export it to some other application.

Your results may differ slightly if your Options or Conductor Data have different settings from those used here.

3.5 INTRODUCING THE TIP LOAD MODULE

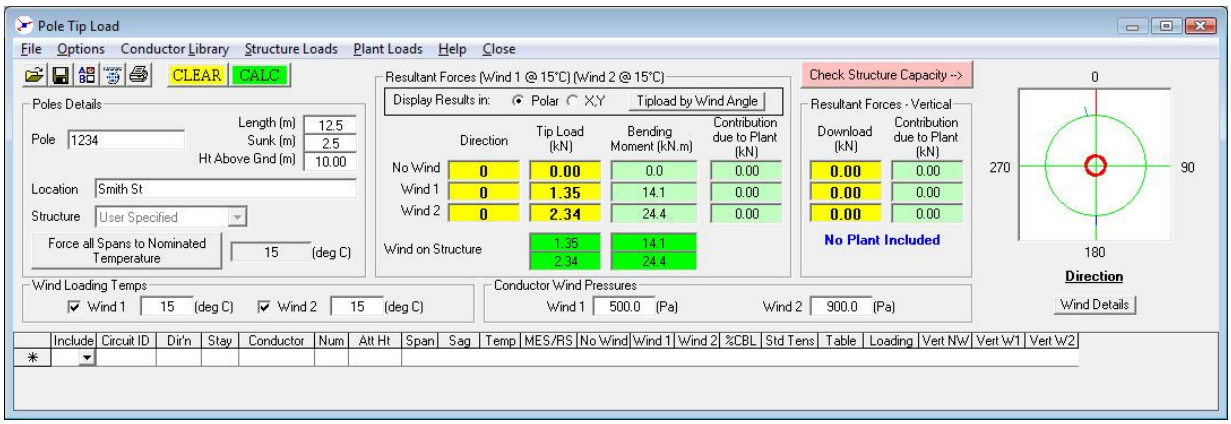
Example 1

A 12.5m long round pole is sunk to a depth of 2.5m. It has the circuits and stays attached as shown in the sketches below. The HV mains are strung at 10% CBL. The LV cable, attached to the pole 2m below the HV, is strung at 5% CBL. Calculate the resultant tip load on the pole.



Activate the *Tip Load* module.

1. Make sure that you have *Options* set for a round pole (refer section 4.2). Enter Pole Length and Sinking Depth (if different from default), as shown below. Notice that the Height of the pole above ground is calculated automatically, viz. 10m. You may also wish to enter the Pole ID and address.



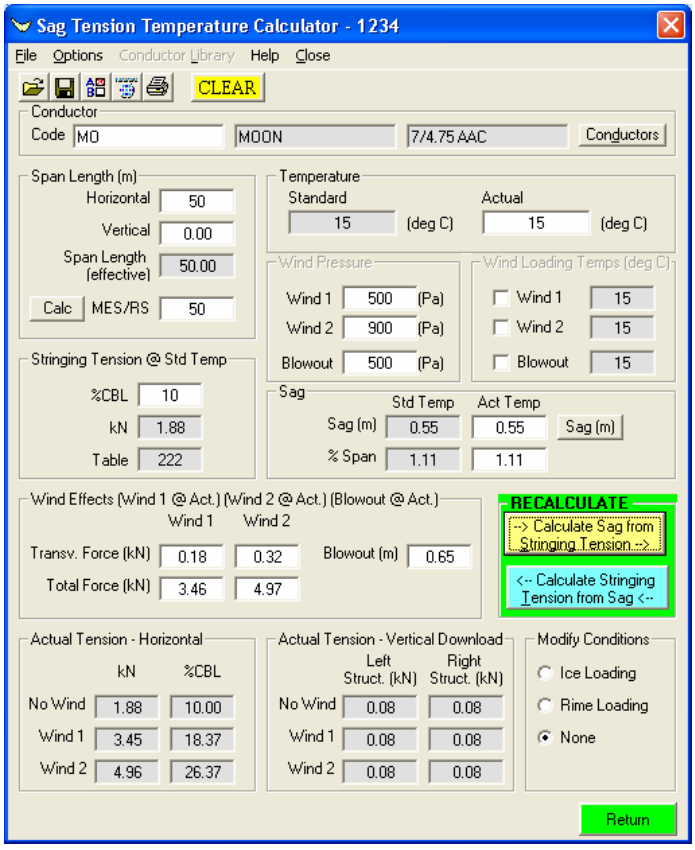
2. Given that our *Options* settings are such that we are including the wind load on the pole itself, and we have a nominal average diameter for the pole, notice that the wind forces on the structure have already been calculated. Of course, if we wished to ignore the pole windage, we could go to *Options*, *Poles/Structures* tab and click on *Deduct Structure Windage from Structure Strength* rather than *Add Structure Windage to Tip Load*. If we wish to amend the diameter of the pole, we could click on *Structure Loads* in the menu bar and adjust the value for pole diameter. If we were to set it to '0', we would eliminate pole wind load altogether.

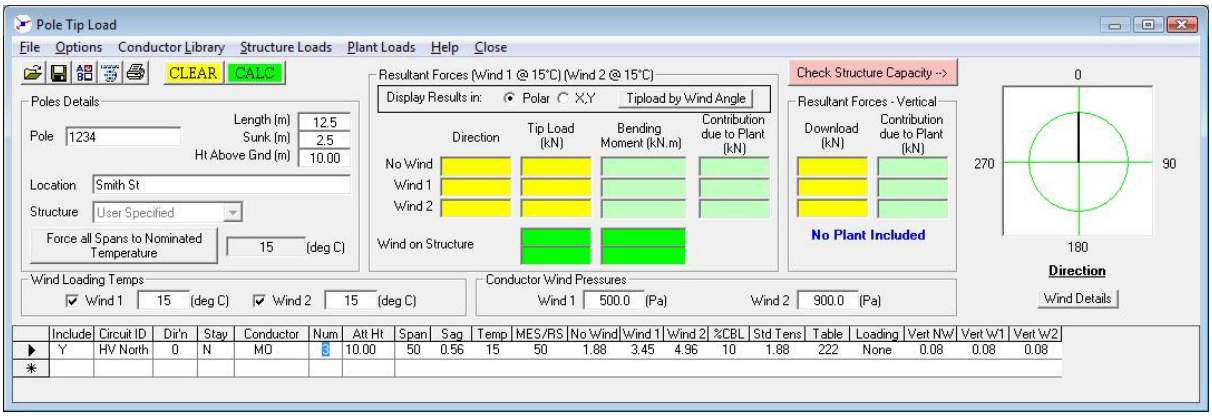
3. We will now enter details of the circuits attached to the pole. (The form may be enlarged if necessary by placing the cursor over the edge of the form, clicking and dragging to resize the window.) Column widths may also be adjusted. Let us start with the HV circuit at direction 0°.

4. You may wish to enter a description of the circuit in the first column, eg "HV North". This is optional.

5. Enter a circuit direction of '0' in the *Dir'n* (Angle) column in the first line of the table. If you then click on the next line of the table, you will notice that this causes a black line to be drawn on the plan diagram corresponding to the circuit at 0°.

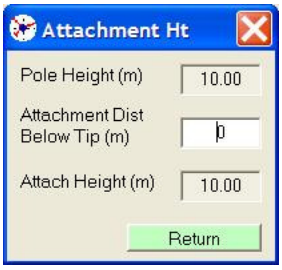
6. Now navigate to or click in the 'Conductor' column in the first line of the table. This activates the *Sag-Tension-Temperature* module. Enter conductor code *MO*, span length of 50m, stringing tension of 10%CBL and ensure the actual temperature is equal to the standard temperature. Click on *Calculate Sag from Tension*. Then click *Return*. Notice that the tensions calculated have been translated into the data grid in the Tip Loads form.





7. Enter the number of conductors – 3 in this instance. (For LVABC, we would enter 1.)

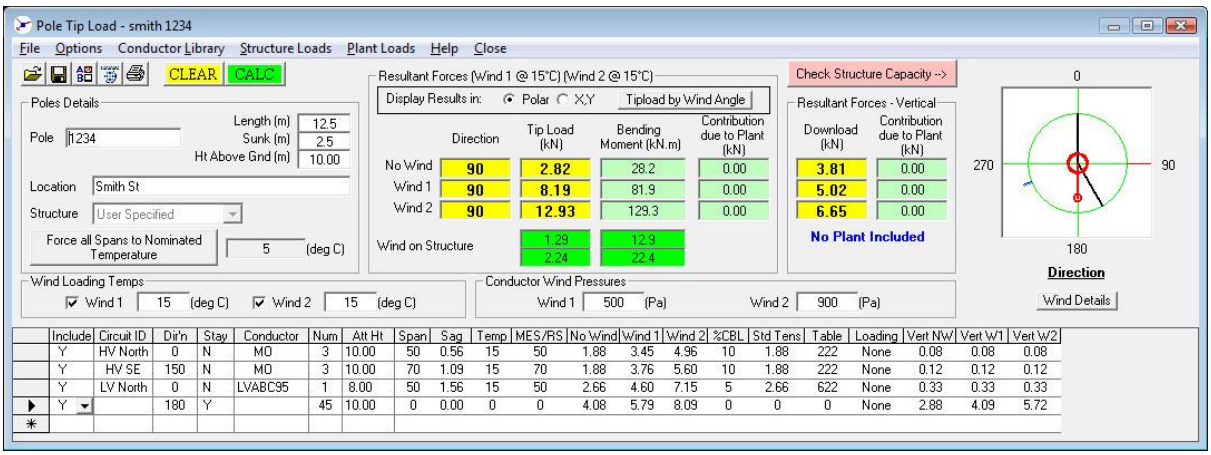
8. The Attachment Height defaults to the top of the pole. You may enter the attachment height directly. Alternatively you may click on the down arrow button at the right side of this column, causing a form to appear which allows entry of the conductor height in terms of distance below the pole top.

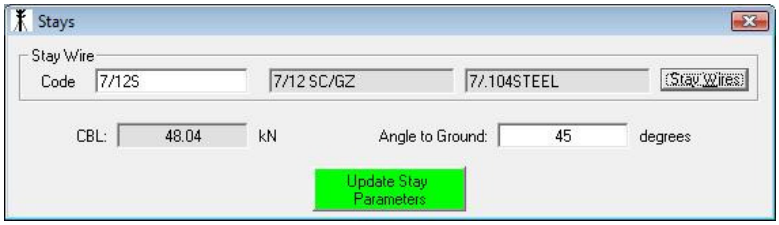


9. This process may be repeated for the two other circuits. Alternatively, you may wish to use the circuit copy feature. To do this, position the cursor over the square panel at the left end of the table line containing the circuit we wish to copy. Click to highlight the entire line. Now right-click the mouse and select option 'Copy Selected Circuit' from the pop-up menu.

   Amend the circuit details as per the first example. Note that details such as span length, %CBL and so forth can only be amended from within the *Sag Tension Temperature* module activated from the button in the 'Conductor' column of the circuits table. You cannot enter data directly into the data grid to the right of the *Att Ht* column.

10. Now enter the stay. To do this, go to a new line in the table and enter the stay direction of 180 in the *Dir'n* (Angle) column. Click on the Stay column to toggle the value to 'Y'. The value in the Num column changes to 45, this is the stay angle to ground (amend this value if the stay is at an alternate angle). Attachment height is unimportant, since the stay is assumed to be ideal. Now click on the next line down in the circuit table. Notice that the plan diagram now shows the stay as a short red line with a circle at its end.
    Optionally, Navigate to or click in the 'Conductor' column (of the Stay line in the table), this activates the *Stay* form. Select the *Stay Wire* (in a similar manner to selecting Conductors), this will display the *CBL* of the *Stay Wire* and the Stay's *Angle to Ground* (default is 45º). Change the Stay's *Angle to Ground* as required and click on *Update Stay Parameters*.





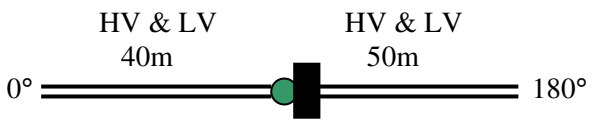
11. Click on the *Calculate* button to determine the tip load upon the pole. Notice that the resultant tip loads are shown for 'No Wind', 'Wind 1' and 'Wind 2' conditions – both as an equivalent tip load and as a bending moment. The direction of the resultant force (worst case) is also shown. (Note that sometimes there may be more than one worst case wind direction, although not for this case). The polar diagram indicates the resultant direction in red/magenta/yellow outside the green circle—in this case they are all aligned at 90º. The blue tick on the circle shows the worst-case wind direction.
    The No Wind, Wind 1, Wind 2 are calculated for the Stay, in the nominated direction, that are needed to balance the other forces.
    Your results may differ slightly if your Options are set differently from those used here.

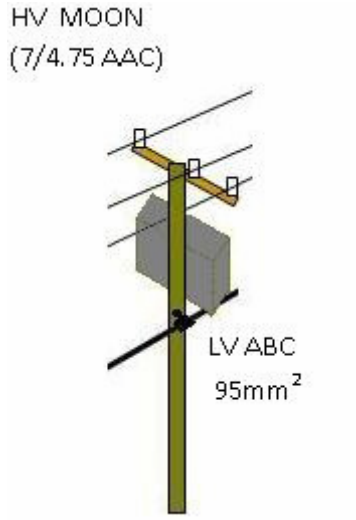
12. You may save the tip load study to disk by clicking on the disk-shaped icon or the *File-Save As* menu. The program will prompt you for the project name. You may wish to enter "Smith 1234", say, which will then cause the default file name for the study to be *Smith 1234.pnw*.

Example 2

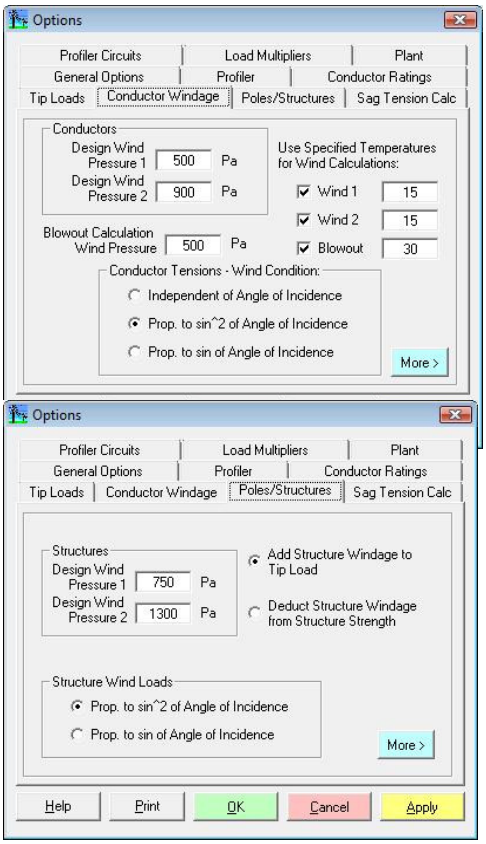
A Wood Pole Structure 14m long 12kN working strength has the circuits and 100kV.A transformer attached as shown in the sketches below. The HV mains are strung at 10% CBL. The LV cable, attached to the pole 4m below the HV, is strung at 5% CBL. Calculate the resultant tip load on the pole.

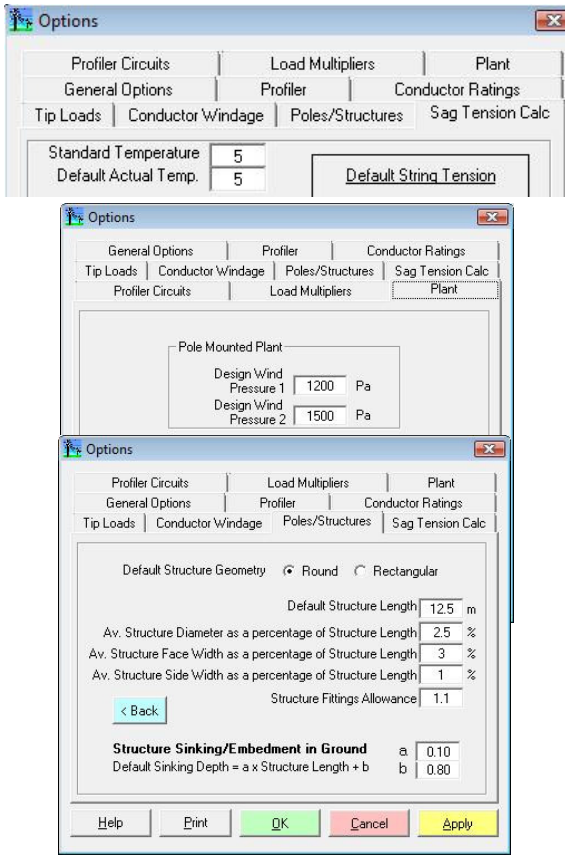
In this instance, we are required to use a standard temperature of 5ºC, 5ºC for the No_Wind load case and 15ºC for the Wind Load case.



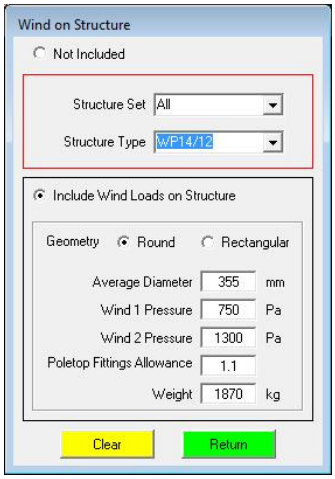


Prior to activating the *Tip Load* module, we need to check our *Options* settings.





1. Select ‘WP14/12’ from the *Structure* list, as shown below, then *Return*. Notice that the pole height and length and entered automatically. You may also wish to enter the Pole ID and address. Again, for the purposes of this example, we will assume that we are including windage on the pole in the calculated tip load, but we could eliminate this by adjusting *Options* settings.

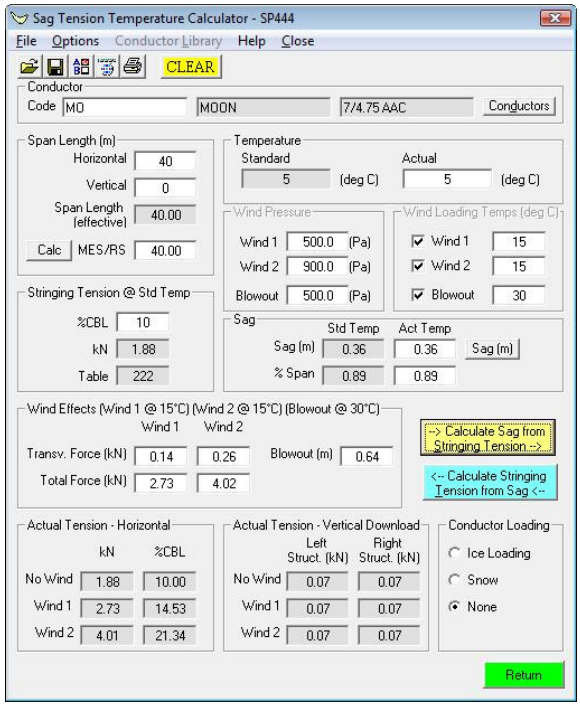


2. We will now enter details of the circuits attached to the pole. (The form may be enlarged if necessary by placing the cursor over the edge of the form, clicking and dragging to resize the window.) Column widths may also be adjusted. Let us start with the HV circuit at direction 0°.

3. You may wish to enter a description of the circuit in the first column, eg “HV North”. This is optional.

4. Enter a circuit direction of ‘0’ in the *Dir’n* (Angle) column.

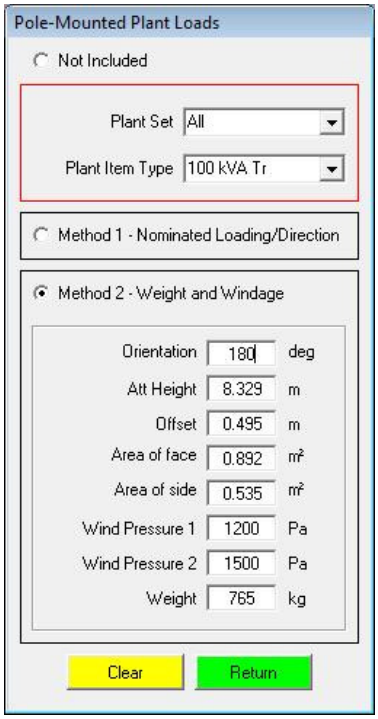
5. Now navigate to or click in the ‘Conductor’ column in the first line of the table. This activates the *Sag-Tension-Temperature* module. Enter conductor code *MO*, span length of 40m, stringing tension of 10%CBL. We have the actual temperature set to 5ºC, and the Wind1 and Wind2 boxes checked and set to 15 ºC. Click on *Calculate Sag from Tension*. Then click *Return*. Notice that the tensions calculated have been translated into the data grid on the Tip Loads form.



6. Enter the number of conductors – 3 in this instance for HV (1 for LVABC).

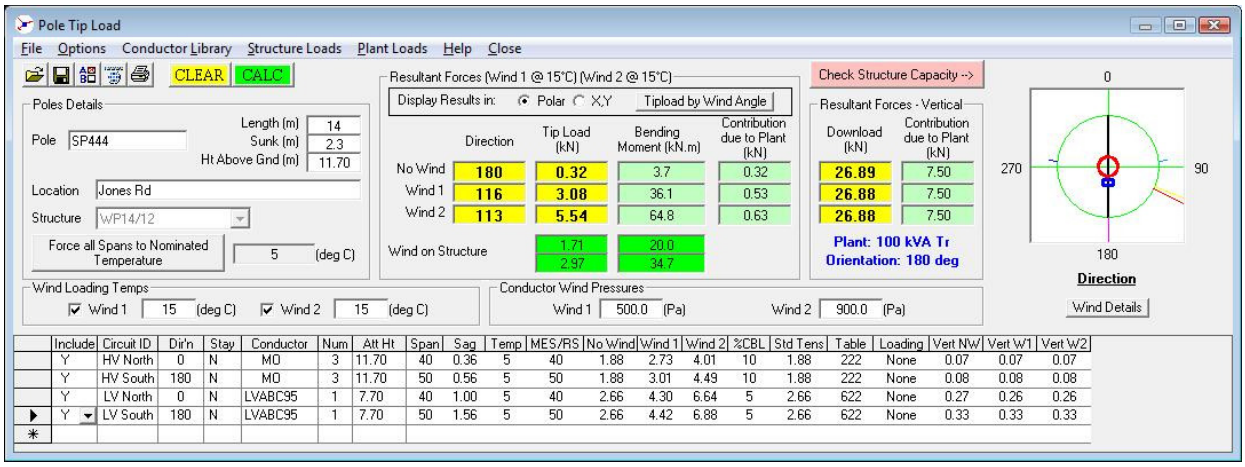
7. The Attachment Height defaults to the top of the pole, which suits us for the HV circuits. (For the LV, enter the attachment height directly, or click on the down arrow button at the right side of this column and enter 4m distance below the tip.)

8. This process may be repeated for the three other circuits, or use the circuit copy feature by positioning the cursor over the square panel at the left end of the table line containing the circuit we wish to copy, clicking the right mouse button and selecting the 'Copy Selected Circuit' option, then amending the details to suit.

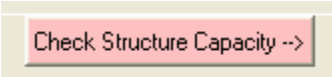


9. Now select the *Plant Loads* menu item, this will open the *Pole-Mounted Plant Loads* form. Select the 100kV.A transformer from the plant list, and enter an orientation of 180º. Click on the *Return* button to return to the *Tip* Load module. The plant item is displayed as a blue rectangle on the south side of the pole.

10. Now click on the *CALC* button. Notice that the No Wind case resultant is in a direction of 180º, obviously due to the plant item weight. However, the resultant loads for the Wind Condition 1 and Wind Condition 2 are at 116º and 113º respectively. It is not unusual for there to be some difference in direction. (To understand what is happening more fully, click on the *Tipload by Wind Angle* button and see the loads calculated for each wind direction analysed.) Notice, too, how the contribution due to plant load is displayed, and how the plant load significantly increases the download force on the structure.

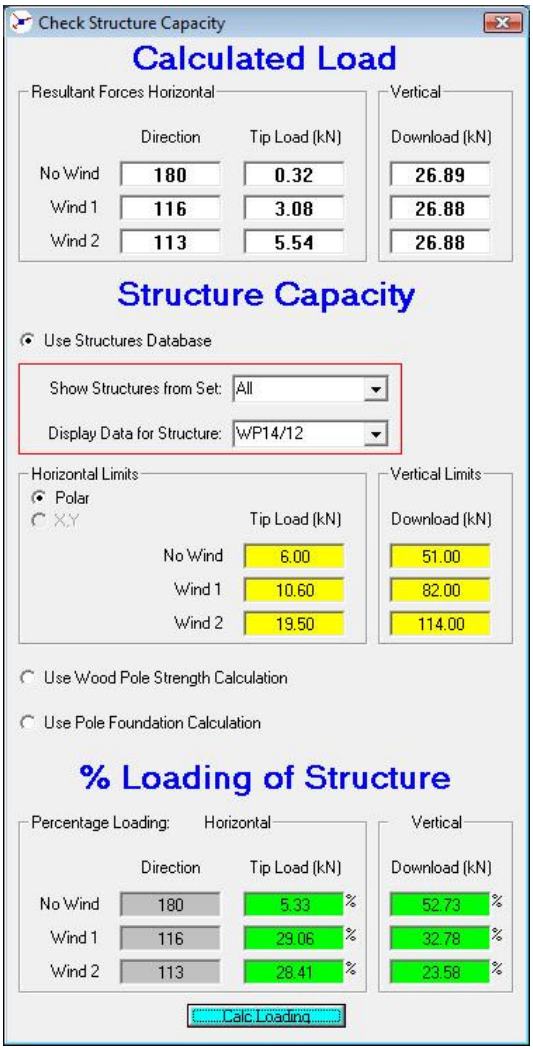


11. Now click on File -> *Check Structure Capacity* (or click on the *Check Structure Capacity* button), this will launch the *Check Structure* Capacity form and fill in the corresponding fields.



12. Click *Calc Loading* to display the *% Loading of the Structure*. Notice that the results are highlighted in green. This means that this structure is strong enough to take the *Calculated Load*.

13. You may save the tip load study to disk by clicking on the disk-shaped icon or the *File-Save As* menu. Again, you will be prompted a project name, and you may wish to enter "Jones Rd SP444".



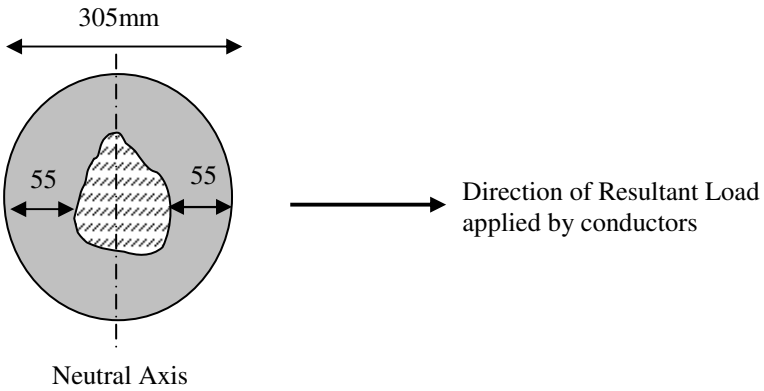
3.6 INTRODUCING THE WOOD POLE STRENGTH MODULE

Example

A 12.5m long timber pole is sunk to a depth of 2.0m. The timber is of the 'Spotted Gum' species, and the pole has been treated with CCA.

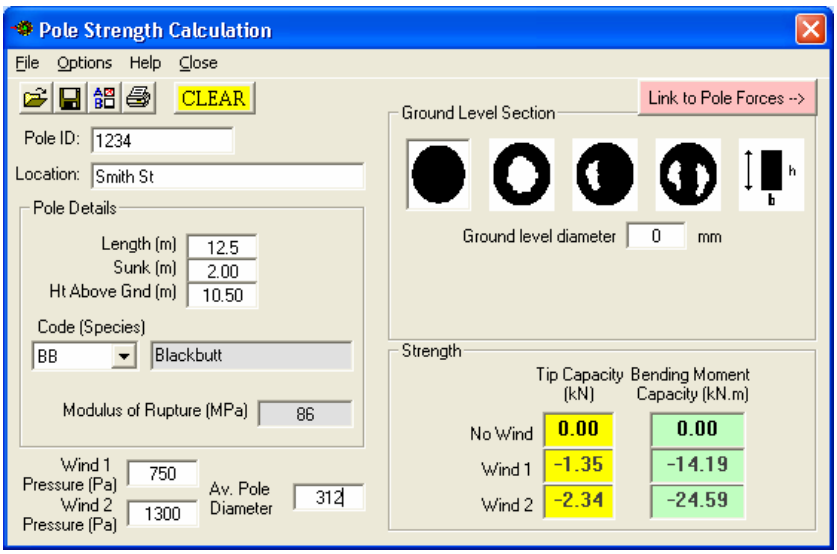
The pole is approximately circular in section, with a ground-line diameter (measured in the direction of the resultant force, slightly below ground, where the pole is narrowest) of 305mm. There is a central hollow due to internal rot, however there is at least 55mm of sound wood all around the circumference (as determined by drilling).

Calculate the tip load capacity, or strength, of the pole.



Activate the Pole Strength module.

1. Enter Pole Length and Sinking Depth, if different from the default, as shown below. Notice that the Height of the pole above ground is calculated automatically, viz. 10.50m. You may also wish to enter the Pole ID and address.

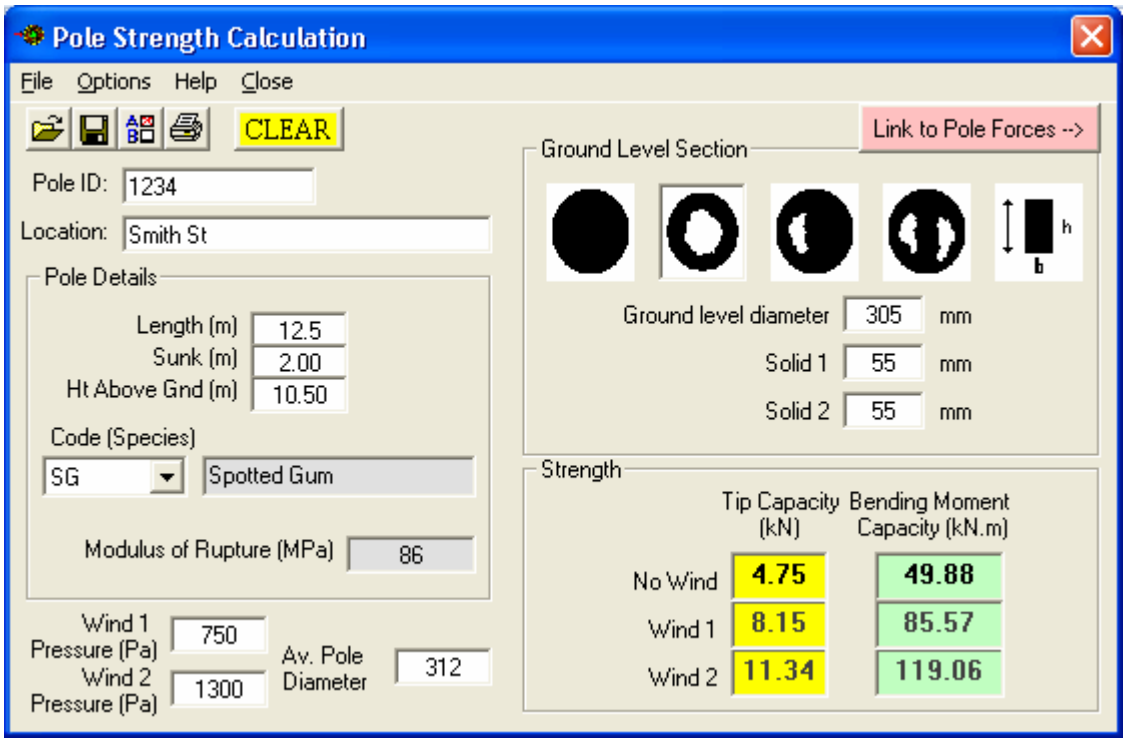


2. Select material code ‘SG’, and notice that the modulus of rupture for this timber is 86MPa.

3. Click on the icon showing a round pole with a central hollow, and enter the ground-line diameter and solid timber measurements for each side.

4. You have the option of deducting the wind load on the pole from the calculated strength of the pole. (Refer section 4.1) If you wish to do this, enter the average pole diameter, adjusting the default value as required. Otherwise this should be set to 0.

5. Resultant tip load capacity (and bending moment capacity) will be automatically calculated as parameters are entered/modified for both ‘No Wind’ and ‘Wind 1’ conditions. If a ‘MSF Wind 2’ value is entered in the *Pole Strength Materials Database* on the *Pole Strength* tab of *Options* (refer section 4.5) then these values will also be calculated for the ‘Wind 2’ condition.



Your results may differ slightly if your Options have different settings from those used here.

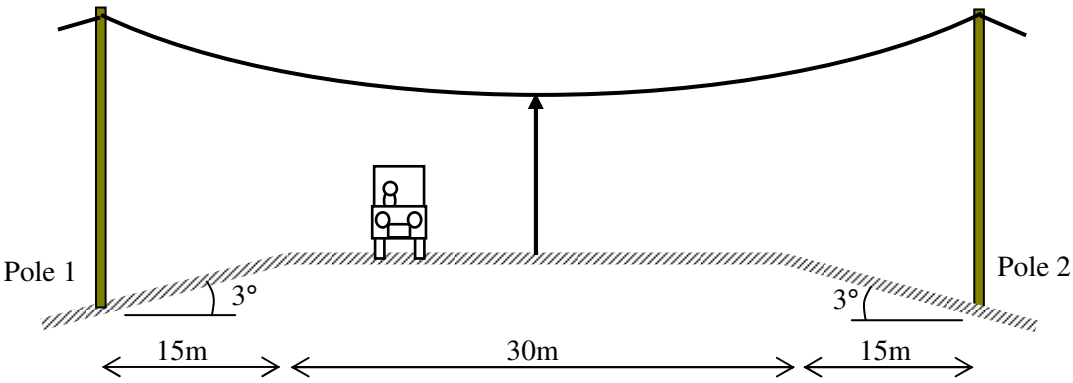
6. You may wish to save the study by clicking on the disk-shaped icon or the *File-Save As* menu.
   The file name will default to *1234.pnw (‘Pole ID’.pnw)*.

3.7 INTRODUCING THE LINE PROFILER MODULE

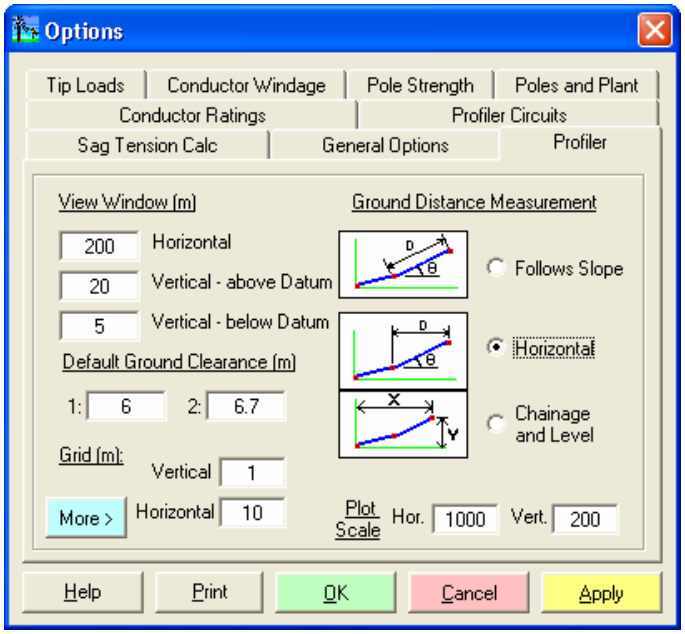
Example 1

A span of HV mains crosses a highway, as shown below. 12.5m long poles, sunk 2.2m, support the span. The poles are set back 15m from the shoulder of the carriageway, down a slight embankment. The conductor is 19/3.75 AAC (PLUTO) strung at 10% CBL.

The road authority requires a min. clearance for HV mains crossing the carriageway of 7.0m. Determine if the arrangement shown will comply.



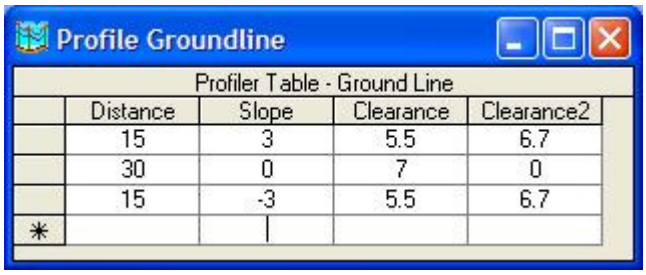
1. Before activating the *Profiler* module, we will check that our *Options* are set up to suit this situation. Here we have ground line data presented in terms of horizontal distances and slope angles. Consequently, we open up *Options* from the main menu toolbar, click on the *Profiler* tab, then check the middle option *Horizontal*. Click on *OK* to close options and retain the selected setting.



2. Now activate the *Line Profile* module. Initially the profile plot is blank.

We will make Pole 1 the start of the profile, at chainage 0m, and Pole 2 the end of the section at chainage 60m.

3. Click on the *Ground Line* button. This will activate the data entry grid shown below.



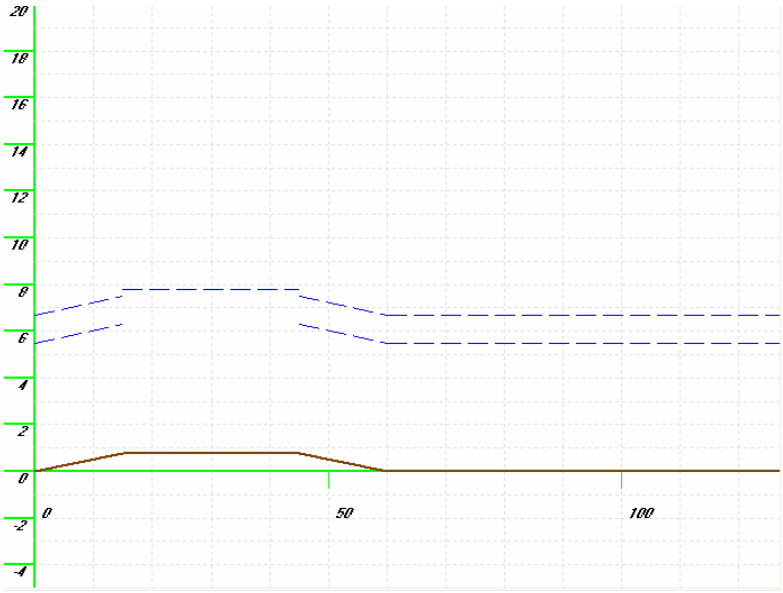
	Distance	Slope	Clearance	Clearance2
	15	3	5.5	6.7
	30	0	7	0
	15	-3	5.5	6.7
*				

Enter details of the segment between Pole 1 and the road (distance 15m and slope 3°) as shown. There is no need to enter clearances, as our default clearances of 5.5m and 6.7m are adequate over the batter. These will appear as we click on the next line down in the grid.

Enter segment 2, the carriageway, with distance 30m and slope 0° and 7m clearance line. The second clearance line can be set to nil.

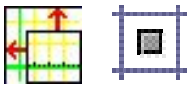
Enter segment 3, the segment between the roadway and Pole 2, with distance 15m and slope -3°. Again this is a bank and standard clearances will be adequate.

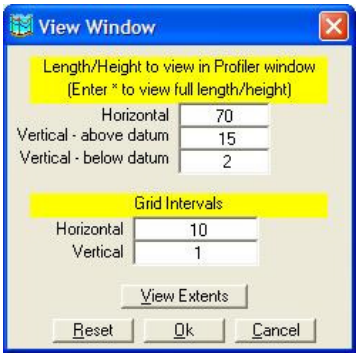
4. While entering ground line data, the ground line profile (brown) and the GL clearance offset lines (blue dashed) are updated on the screen, as shown.



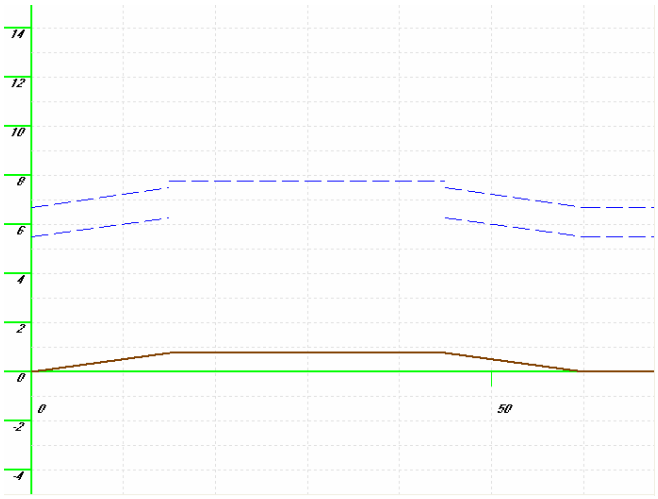
You may close the GL data grid form by clicking on the 'X' in the top right corner of the window.

5. Note that the GL plot is small relative to the view window, covering only 60m of the window's 200m width. Therefore, we will alter the *View Window* settings. Click on the Profile Bounds icon shown below, and alter the horizontal width of the window to 70m, say – just a little more than the 60m we need. We will also drop the vertical height and depth relative to the datum line as shown. Alternatively, we could click on the 'View Extents' button (which is also available directly from the *Profile* Window).

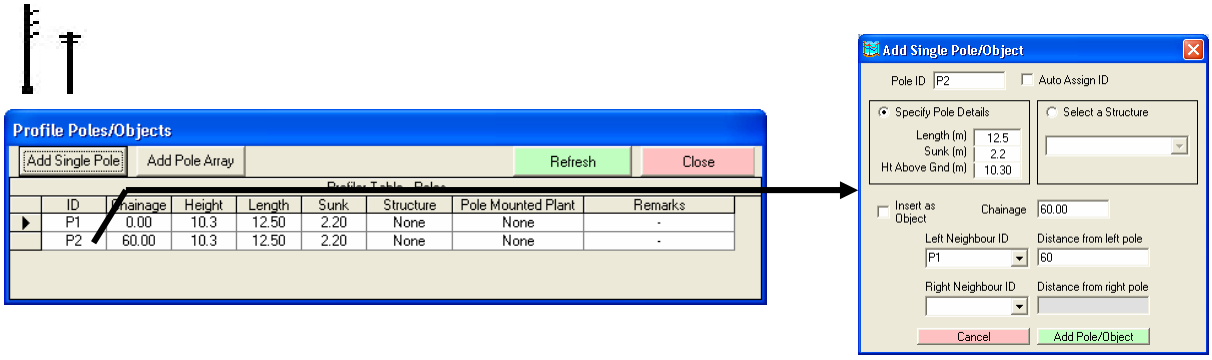




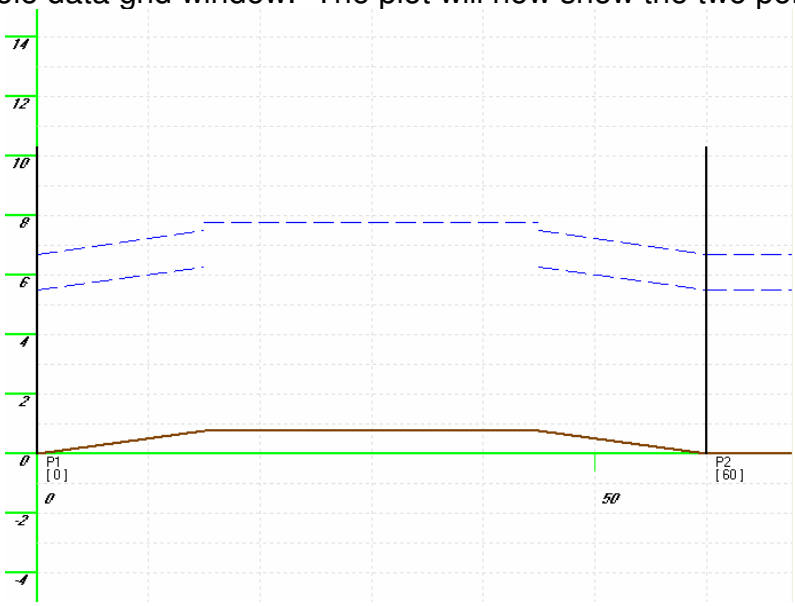
Click on *OK* to close the View Window form. The plot will be rescaled, as shown below.



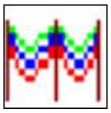
6. Click on the *Poles* button and enter 2 poles into the data grid. The chainage of Pole 1 is 0m. It is 12.5m long, sunk to a depth of 2.2m, making its height 10.3m. Pole 2 is identical, but at a chainage of 60m. We can enter pole data by clicking on 'Insert Single Pole'. We can either enter chainage directly, or enter the span length relative to the neighbouring pole.

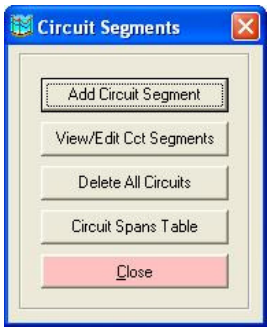


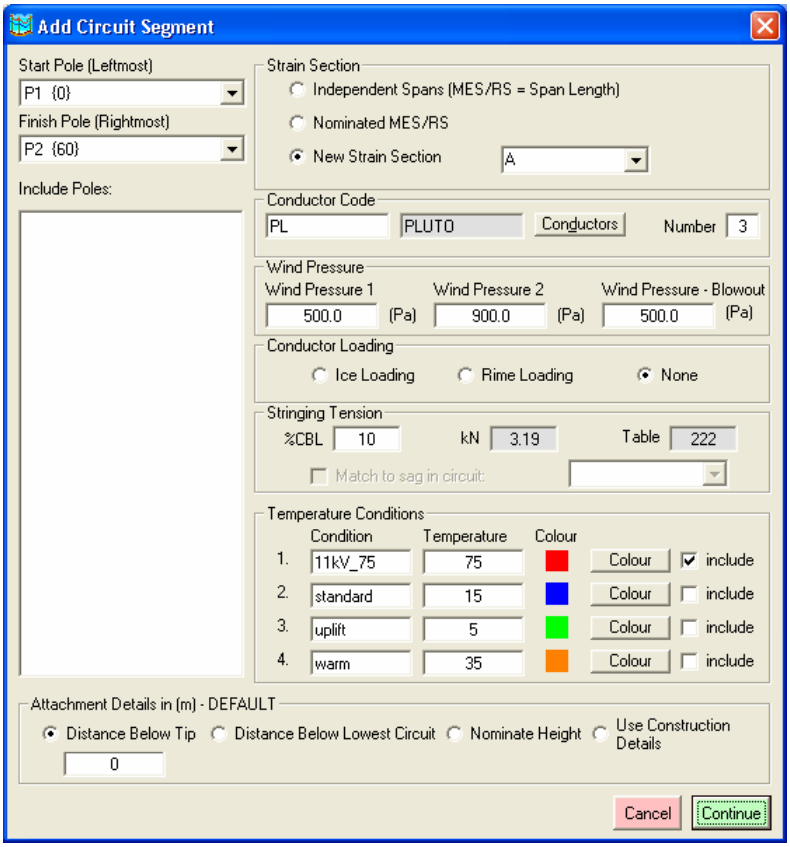
7. Close the pole data grid window. The plot will now show the two poles.



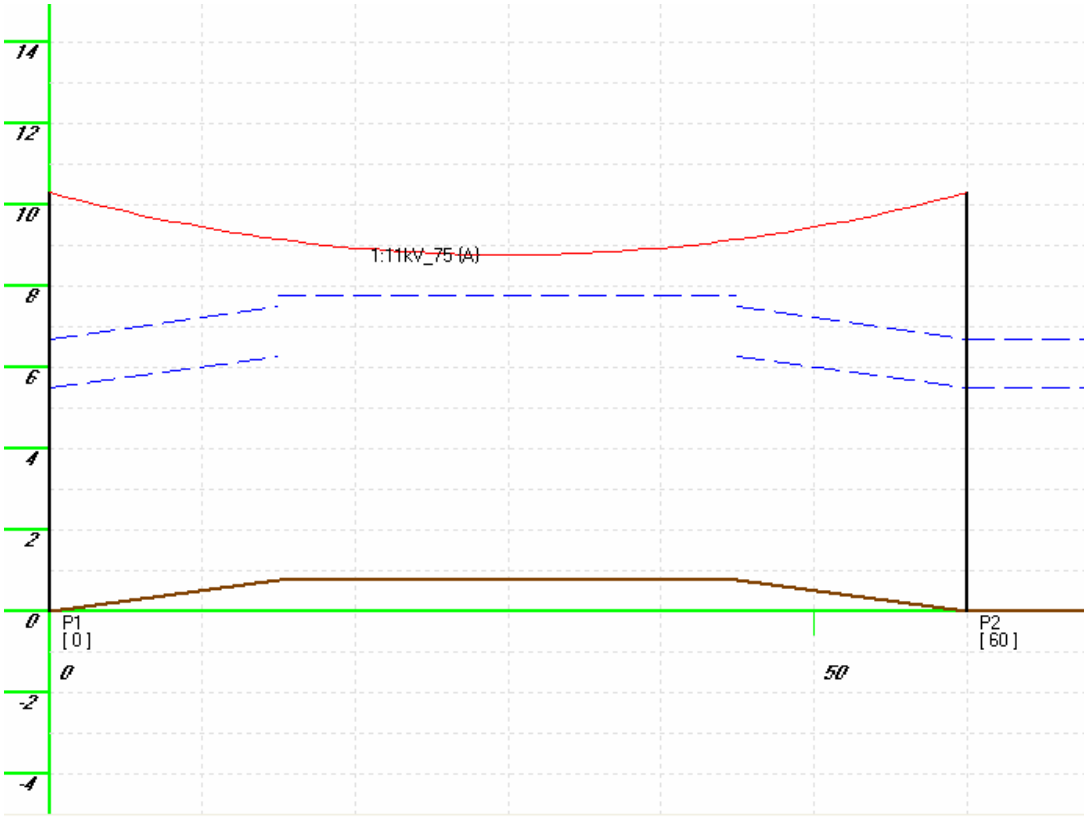
8. Click on the *Circuit Segments* button which will open the *Circuit Segments* form and click on *Add Circuit Segment*. Select 'P1' as the left-most pole and 'P2' as the right-most pole. Enter details for the 11kV line as shown below. This strain section is nominated as 'A', with the MES/RS calculated based upon the span lengths within this segment. Click *continue* this will then launch the *Pole Attachment Height* form, click *continue* again to create and draw in the segment.



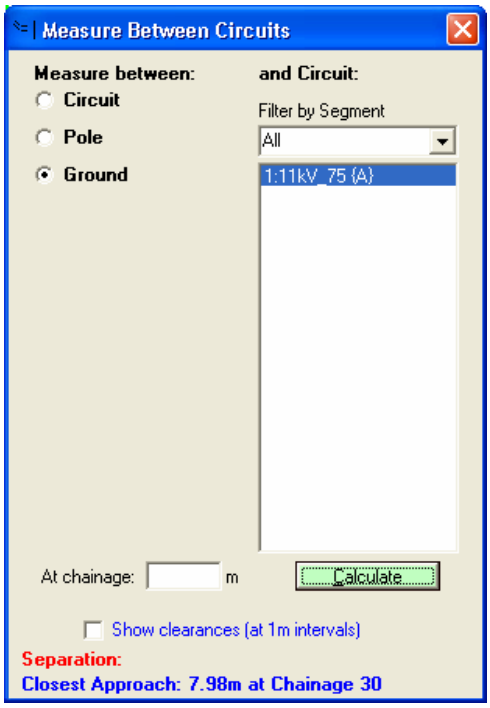




Notice that the catenary curve that has been drawn does not fall below the 7.0m clearance line, and therefore we are satisfied that the arrangement complies with the requirements of the road authority.



11. Should we wish to determine the precise height of the circuit midspan, click on the 'Measure' icon. Select Ground and Circuit 1, then click on *Calculate*. Notice that we have a minimum ground clearance of 7.98m at the middle of the span at chainage 30.



12. You may wish to save the study by clicking on the disk-shaped icon or the *File-Save As* menu. The file name will have an extension *.pnw*. You will be given an opportunity to enter a name/number for the project and nominate the location to save to.

Example 2

A 420m long length of line is to be constructed, with 66kV at the top of the pole and 22kV attached to the poles 2m below this. The 22kV is a flat construction. The 66kV circuit is to be constructed from SATURN strung at 10% CBL and the 22kV from PLUTO, also at 10%CBL.

The route has been surveyed, with the levels (relative to the start of the route) recorded as follows:

Chainage	Level
0	0.00
47	3.70
89	4.12
177	3.02
199	2.05
269	1.32 (pond)
370	2.86
420	1.97

The design shall use 17m long poles, sunk 2.6m, positioned at chainages of:
0, 72, 180, 319, 420.

Draw a profile of the ground line and circuits, showing the circuits at 5°C, 15°C and 75°C.

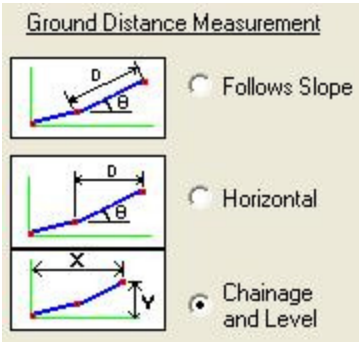
Check that ground clearance is at least 6.7m throughout.

Check that there is at least 1m clearance mid-span between the 66kV @ 75°C and the 22kV @ 15°C.

Check there is no uplift on any of the intermediate poles.

Determine the tip loads on the end strain poles.

1. Enter *Options* and on the *Profiler* tab select Chainage and Level format for groundline data.



2. Open the *Line Profile* module.

3. Enter ground-line data in the Chainage/Level format shown. There is no need to adjust the clearance heights—the default values are acceptable.

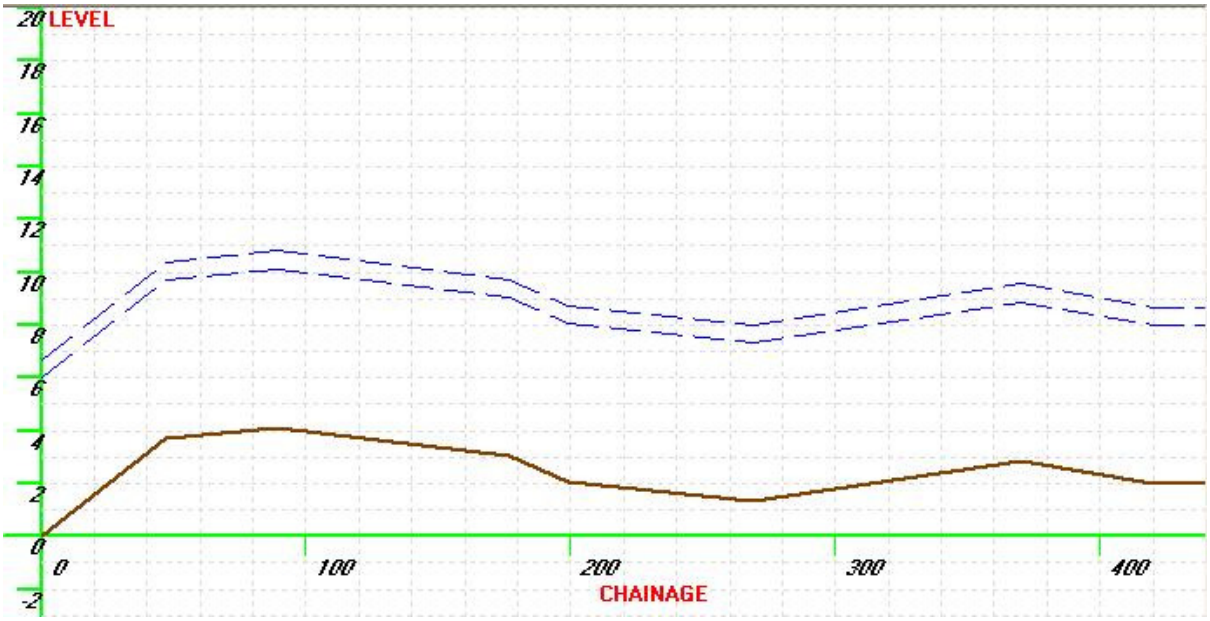
Profile Groundline

Profiler Table - Ground Line

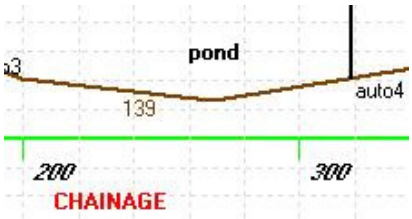
	Chainage	Level	Clearance	Clearance2
	0	0	6	6.7
	47	3.7	6	6.7
	89	4.12	6	6.7
	177	3.02	6	6.7
	199	2.05	6	6.7
	269	1.32	6	6.7
	370	2.86	6	6.7
	420	1.97	6	6.7
*				

4. Adjust the view window size, viewing the extents of the profile.

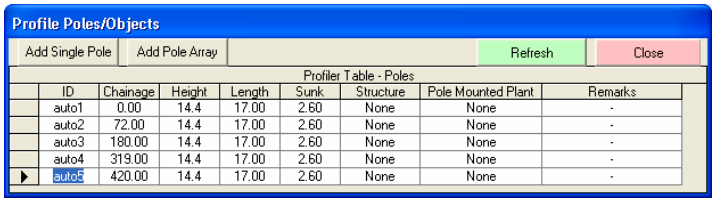
The ground line profile will appear as shown below.



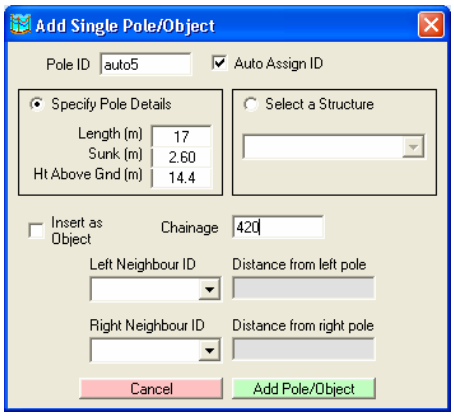
5. We annotate the profile to show the pond. Click on the *Add Text* button on the right side of the screen, then click on the profile screen at around chainage 260, a little above the ground line. Next enter the text "pond". This text will be overlaid on the profile.



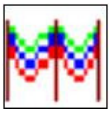
6. We now enter poles at the nominated chainages. We auto-assign pole ID numbers.

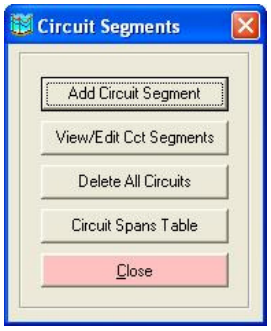


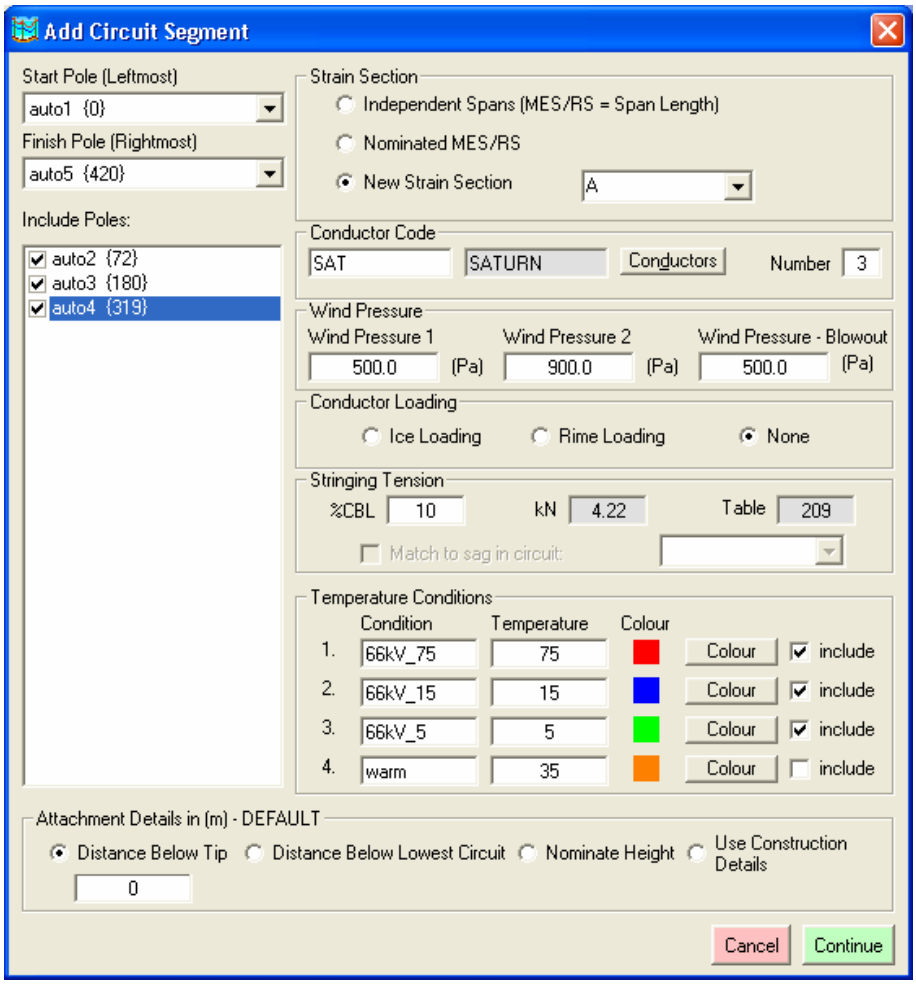
ID	Chainage	Height	Length	Sunk	Structure	Pole Mounted Plant	Remarks
auto1	0.00	14.4	17.00	2.60	None	None	-
auto2	72.00	14.4	17.00	2.60	None	None	-
auto3	180.00	14.4	17.00	2.60	None	None	-
auto4	319.00	14.4	17.00	2.60	None	None	-
auto5	420.00	14.4	17.00	2.60	None	None	-



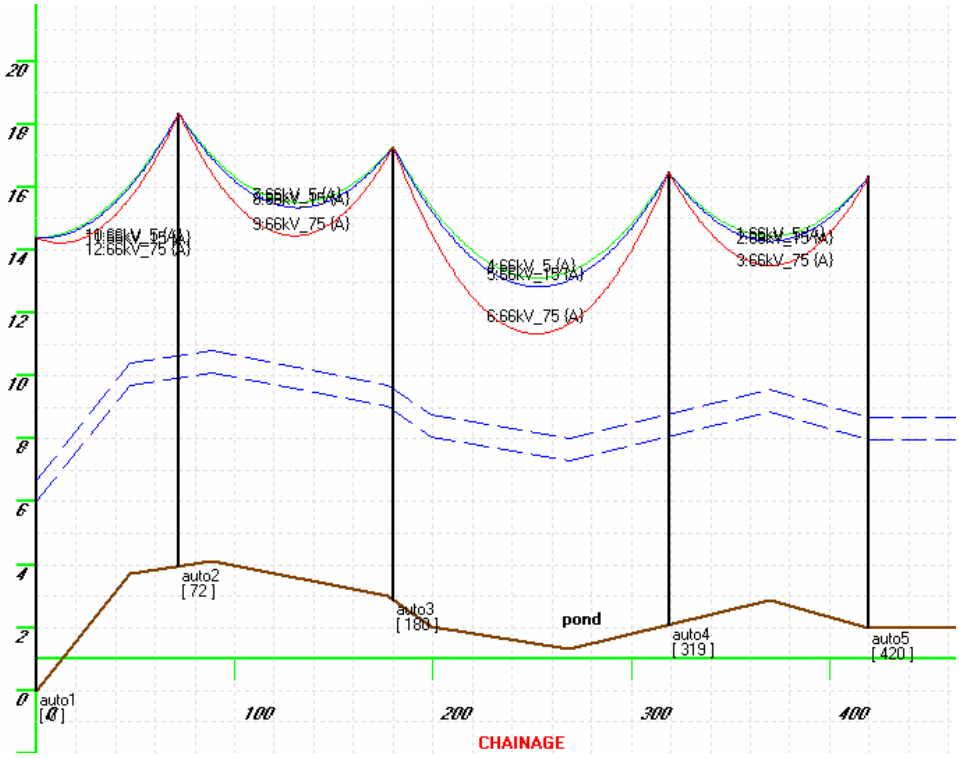
7. We now open the *Circuit Segments* form and click on *Add Circuit Segment*. Select 'auto1' as the left-most pole and 'auto5' as the right-most pole. Check all poles in between as supports. Enter details for the 66kV line as shown below. This strain section is nominated as 'A', with the MES/RS calculated based upon the span lengths within this segment. Click *continue* this will then launch the *Pole Attachment Height* form, click *continue* again to create and draw in the segment.



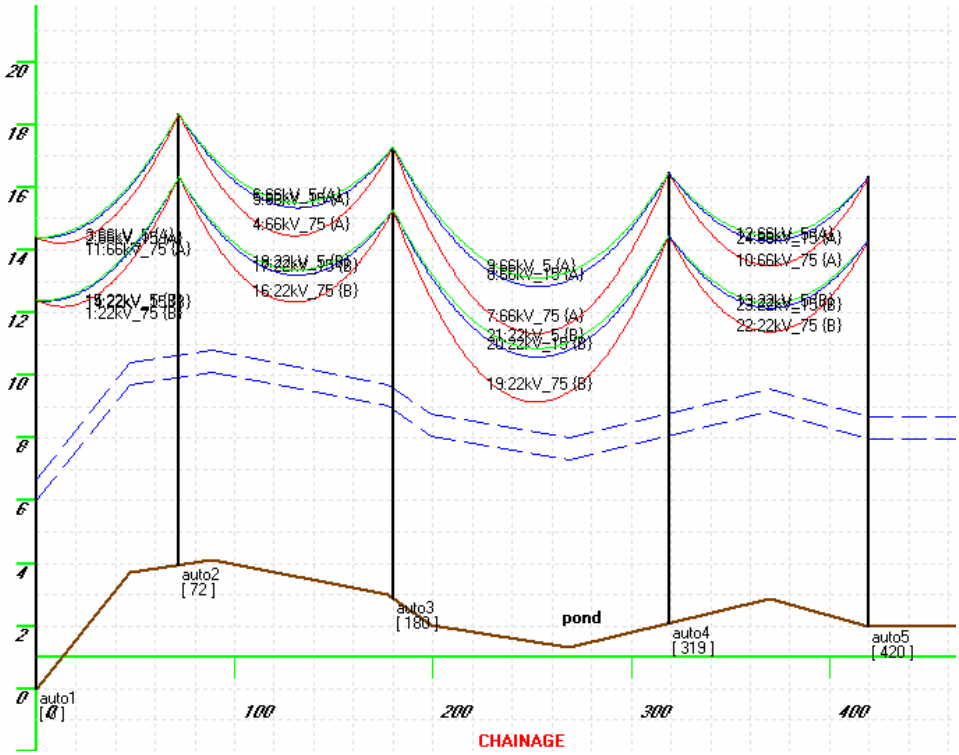




8. The profile now has the following appearance:

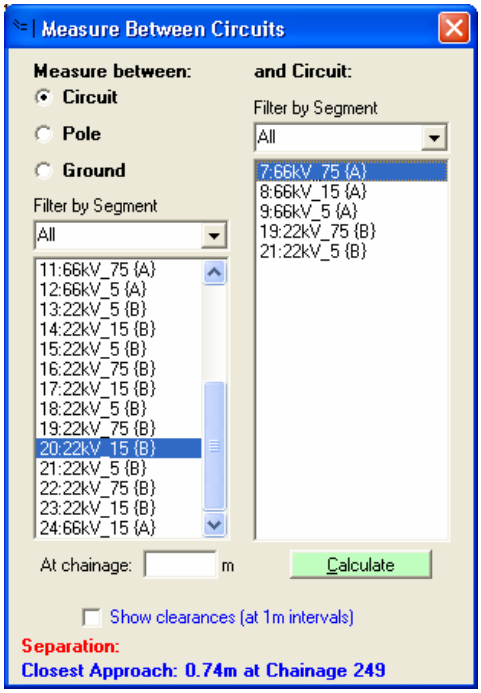


8. We now repeat step 7, except that we use conductor code 'PL', assign as strain section 'B', and set attachment height equal to 2m below the pole tip.



10. Clearly, the 'hot' curve for the 22kV line is well above of the 6.7m clearance line. There may even be space for future LV or telecommunications cables below the 22kV.

11. The long span between poles 'auto3' and 'auto4' is where there is likely to be intercircuit clearance problems. We use the Measure function to check the closest approach between the 66kV 'hot' 75°C circuit and the 22kV 'standard' 15°C circuit.

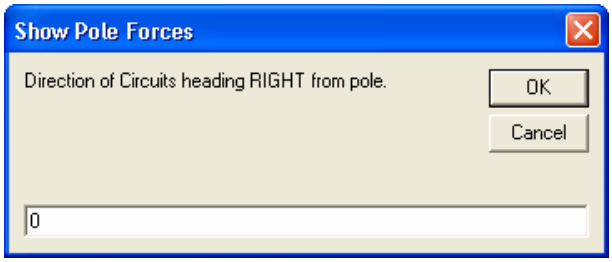


The spacing is only 0.74m, less than the 1.0m we require. Consequently, the span will need to be shortened, the supercircuit tightened or the subcircuit slackened.

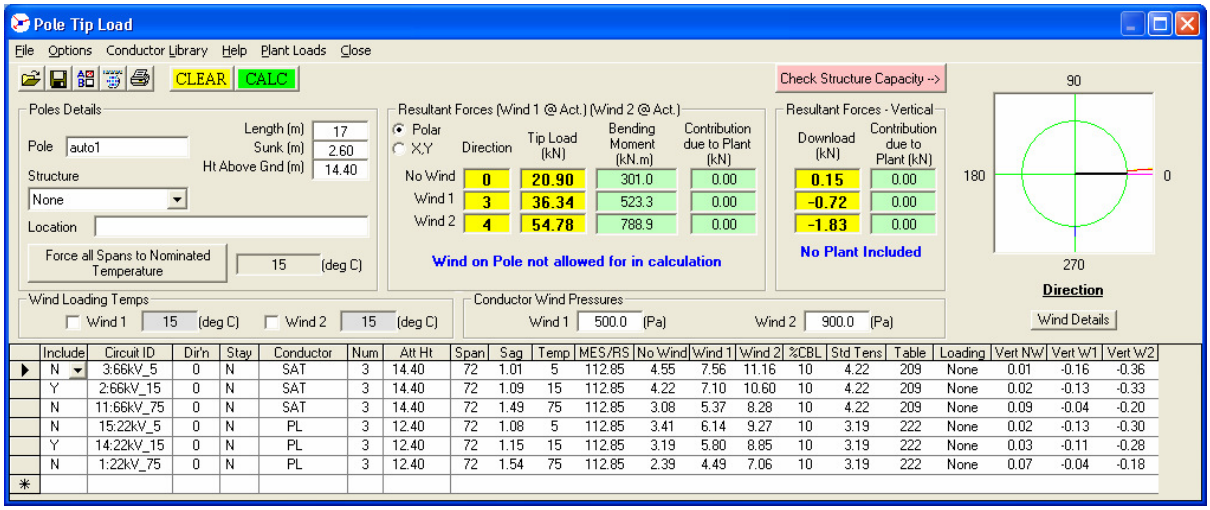
12. Looking at the uplift curve, there may be some slight uplift on pole 'auto1', but this is acceptable as it is a strain pole. There is no uplift evident on any of the intermediate poles.

Uplift is evident when the lowest point of the circuit span is at the pole at the low end rather than a point within the circuit span, ie the span rises immediately adjacent to the pole instead of sagging down. If uplift exists, you will need to use a strain construction or similar, or else alter pole position, increase pole height or reduce conductor tension.

13. We now wish to check the forces on the end poles. We move the cursor over the first pole, which will be identical to the last pole in this regard, and click on the right mouse button. We select the option *Show Pole Forces* from the pop-up menu. This links us to the *Tip Load* module where you will be prompted for the direction of the circuits heading right from the pole.



14. Enter 0 (degrees) and click *OK,* this will open the Tip Load module with all circuits on the pole pre-loaded. We set the *Include* column to 'N' for all except the two standard circuits, set the number of conductors per circuit to 3 and then click *Calculate* to determine the pole tip forces when the pole is unstayed.



Example 3

A 100m 11kV extension is to be constructed to feed a 315kVA Transformer servicing a small industrial estate (100m of LV). The 11kV is to be MOON strung at 5% CBL and the LV is to be LVABC95 also strung at 5% CBL.
The route has been surveyed and all found to be level (therefore we don't have to worry about the ground line in the profile).

The existing start pole is a WP12.5/8 (Wood Pole Structure 12.5m long 8kN working strength) positioned at chainage 0.

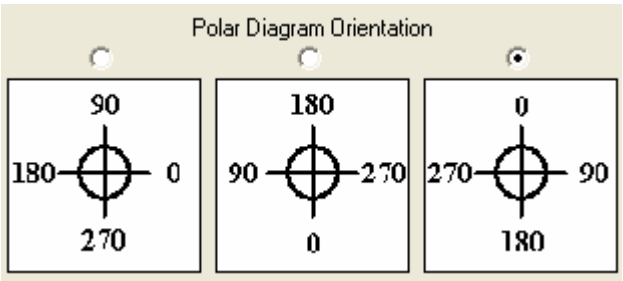
The design shall use a second WP12.5/8 pole positioned at chainage 50, a WP12.5/12 (Wood Pole Structure 12.5m long 12kN working strength) for the transformer pole positioned at chainage 100 and WP11/8 (Wood Pole Structure 11m long 8kN working strength) for the remaining 3 poles at chainages: 140, 180 and 200.

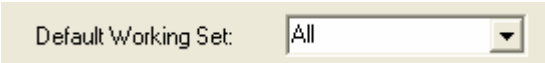
Draw a profile of the ground line and circuits, showing the circuits at 15°C and 75°C.

Check that ground clearance is at least 6.7m for 11kV and 5.5m for LV throughout.

Determine the tip load on the transformer pole.

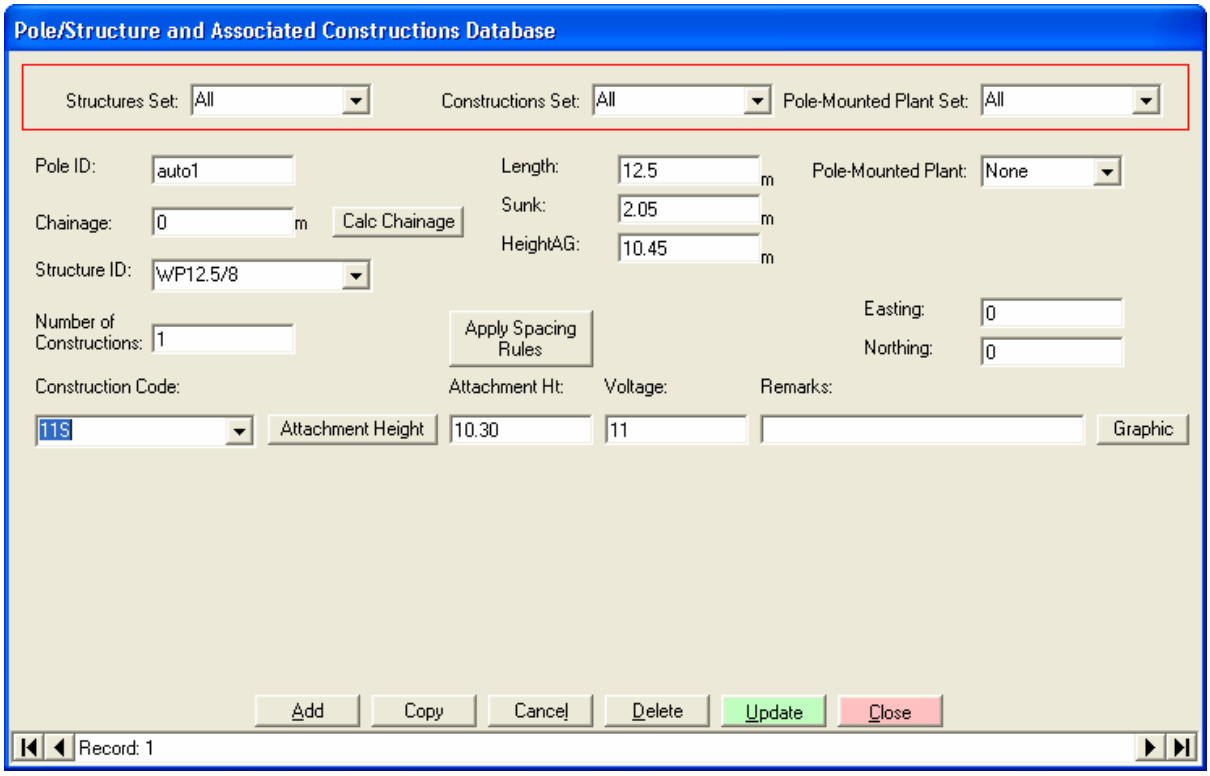
1. Enter *Options*, on the *Tip Loads* tab select the following Polar Orientation and on the *General Options* tab select 'All' for the Working Set.





2. Open the *Line Profile* module.

3. We now open the *Pole/Structure and Associated Constructions Database*. The first pole is an existing WP12.5/8 with an 11kV Termination (Strain Construction) at 10.3m, we will convert the Termination to a Shackle (Strain Construction). Therefore we start by checking the *Auto Assign ID* box, enter a *Chainage* of '0' and select 'WP12.5/8' from the *Structure ID* list. Enter '1' for *Number of Constructions* and select '11S' (11kV Shackle Construction) from the *Construction Code* list (If the *Attachment Height* is not already at '10.30' please enter 10.30 in the *Attachment Ht* textbox).

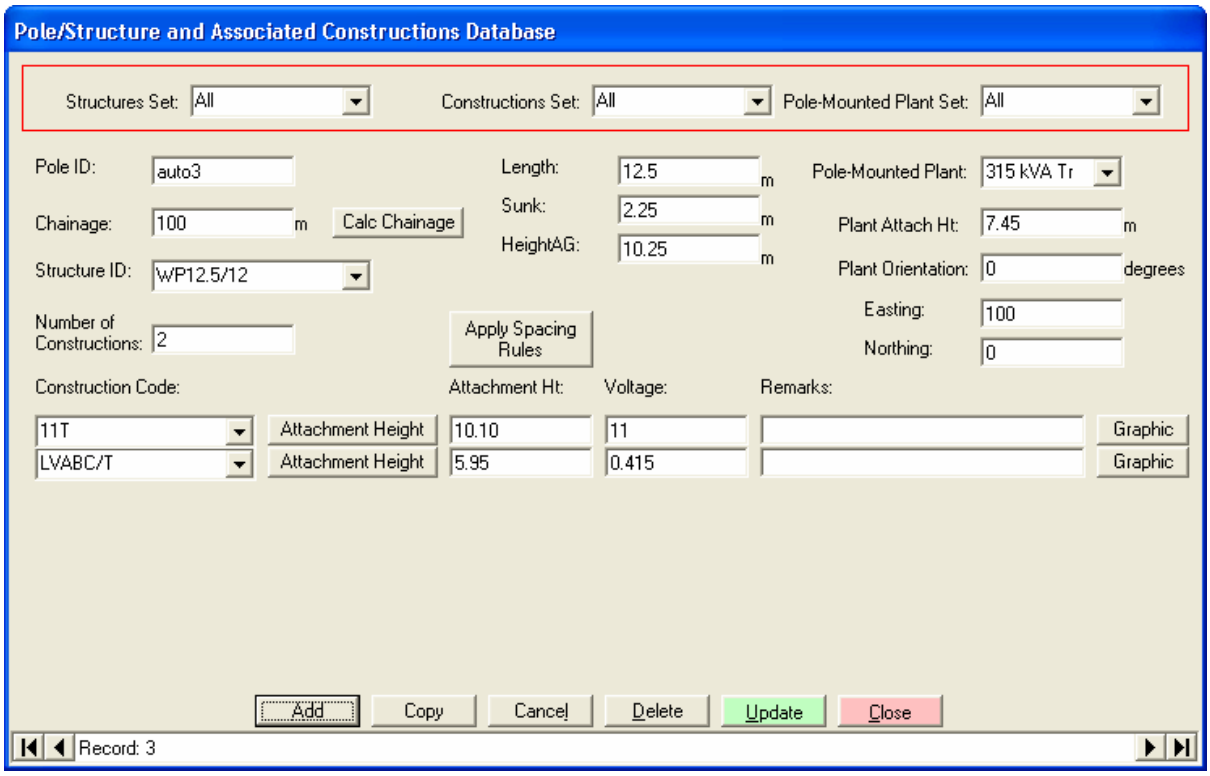


All the rest of the values should be correct, now click *Update* (This will update the *Profile*).

4. To Add the second pole we click *Copy* (as the pole parameters are very similar). Enter a *Chainage* of 50, change the *Construction Code* to '11TD' (11kV Trident Construction) (Intermediate Construction) and click on *Update* again.

The Trident construction extends vertically above the attachment point on the structure to allow a tighter horizontal grouping of the conductors (the middle phase is raised above the outer phases). This is drawn by a grey extension from the pole tip to the top conductor attachment point (not necessarily the top of the construction). Two horizontal grey lines are also drawn to represent the conductor attachment points of the Trident construction.

5. The next pole is the transformer pole, click on *Add*. Enter a *Chainage* of '100' and choose 'WP12.5/12' for the *Structure ID* (we use a stronger pole because the pole needs to handle the extra weight and windage applied to it by the transformer). Enter '2' for *Number of Constructions* and select '11T' (11kV Termination) (Strain Construction) and 'LVABC/T' (LV Aerial Bundled Cable Termination) (Strain Construction) respectively (ensure that the *Attachment Height's* are '10.10' and '5.95'). Now select '315 kVA Tr' (315 kVA Transformer) from the *Pole-Mounted Plant* list, enter '7.45' m for the *Plant Attach Ht* and '0' degrees (West) for the *Plant Orientation*. Click *Update*.

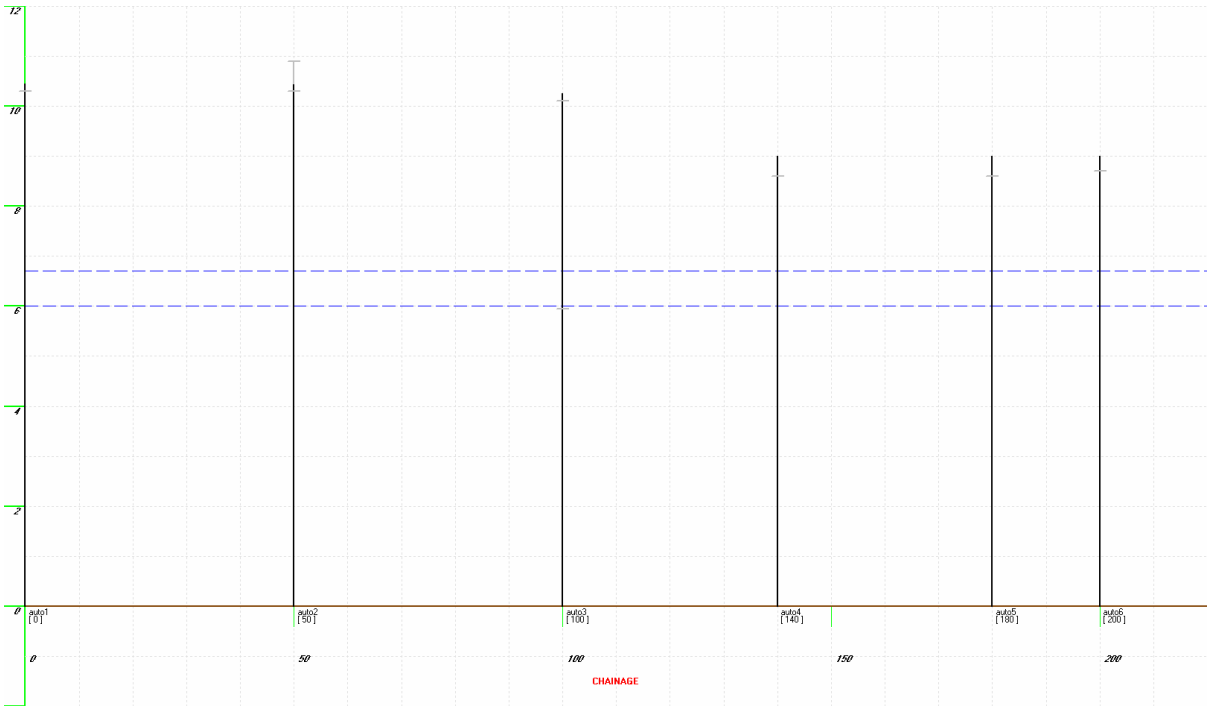


6. Click on *Add* to add the next pole, enter a *Chainage* of '140', 'WP11/8' for *Structure ID* (we no longer need tall poles as only LV from this pole on), '1' in *Number of Constructions*, select 'LVABC/SU3' (LV Aerial Bundled Cable Suspension) (Intermediate Construction) for *Construction Code* (ensure *Attachment Height* of '8.7') and click *Update.*

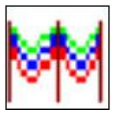
7. To Add the next pole we click *Copy* (as the pole parameters are the same). Enter a *Chainage* of 180 and click *Update.*

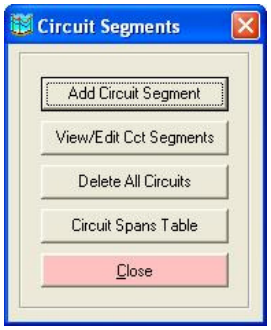
8. To Add the final pole we click *Copy* (as the pole parameters are very similar). Enter a *Chainage* of 200, change the *Construction Code* to 'LVABC/T' and click on *Update*.

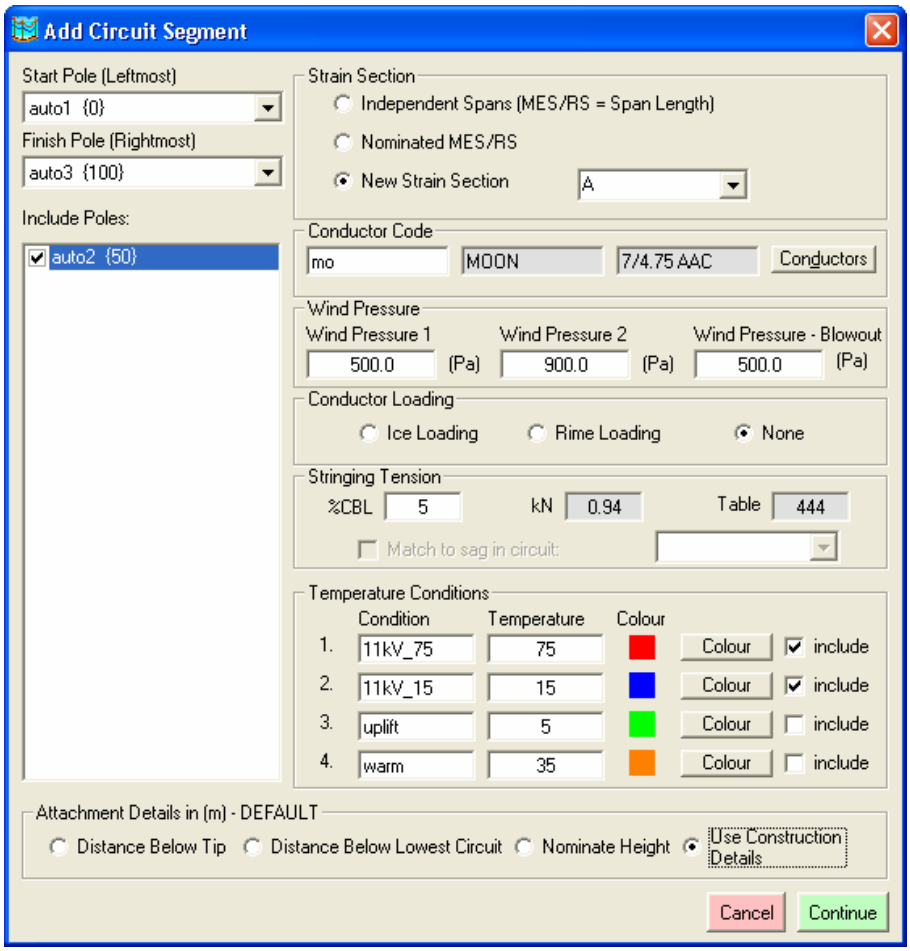
9. Close the *Pole/Structure and Associated Constructions Database* form, click on the 'View Extents' button and the *Profile* should look like this:



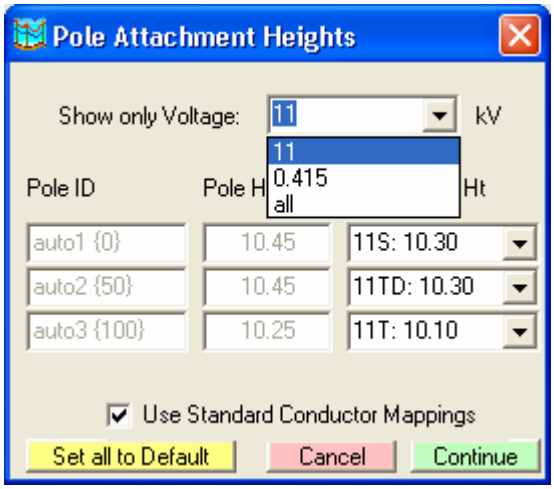
10. We now open the *Circuit Segments* form and click on *Add Circuit Segment*. Select 'auto1' as the left-most pole and 'auto3' as the right-most pole. Check all poles in between as supports. Enter details for the 11kV line as shown below (note *Use Construction Details* is selected in *Attachment Details*). This strain section is nominated as 'A', with the MES/RS calculated based upon the span lengths within this segment. Click *continue* this will then launch the *Pole Attachment Height* form.



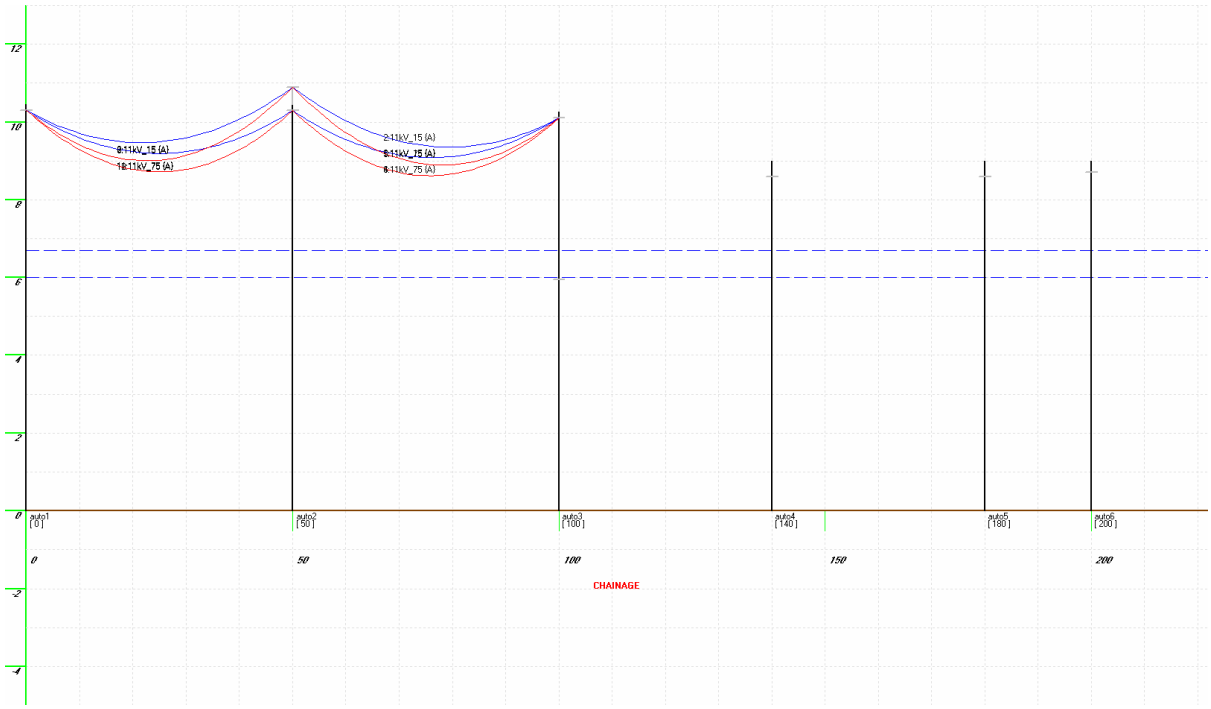




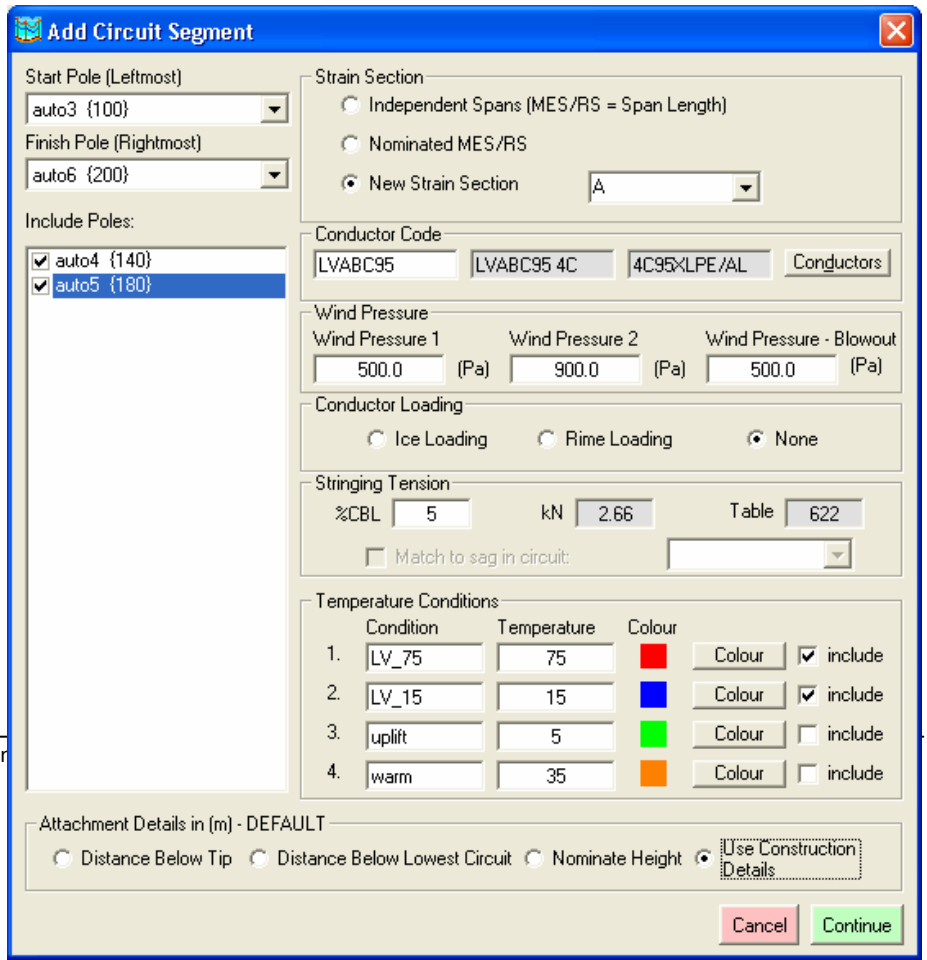
11. Select '11' kV from the *Show only Voltage* list, ensure *Use Standard Conductor Mappings* is checked and click *Continue*.

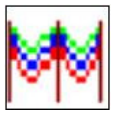


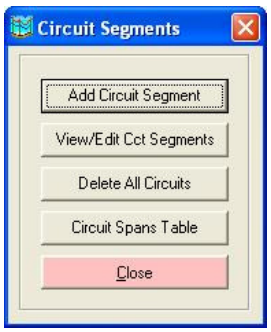
12. The profile now has the following appearance:



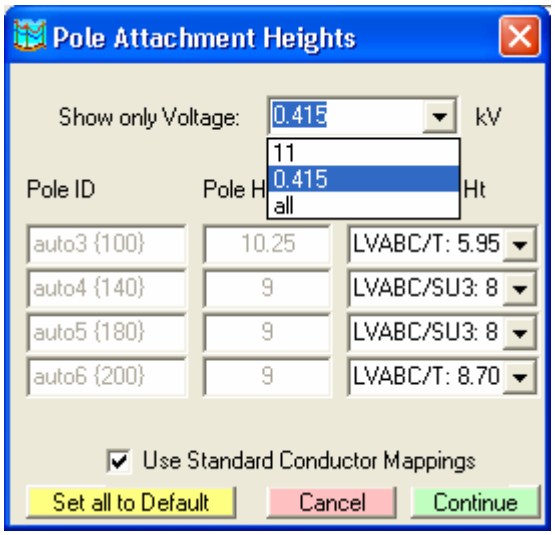
13. Click on *Add Circuit Segment* again. Select 'auto3' as the left-most pole and 'auto6' as the right-most pole. Check all poles in between as supports. Enter details for the LV line as shown below (note *Use Construction Details* is selected in *Attachment Details*). This strain section is nominated as 'B', with the MES/RS calculated based upon the span lengths within this segment. Click *continue* this will then launch the *Pole Attachment Height* form.



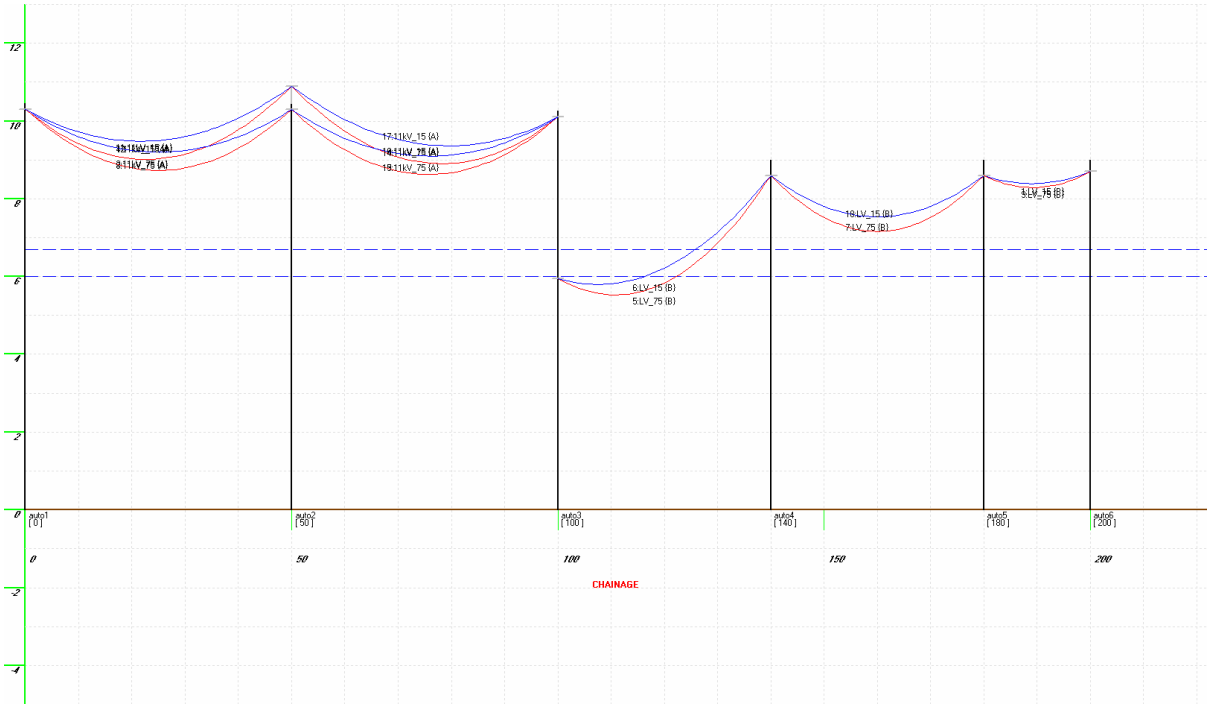




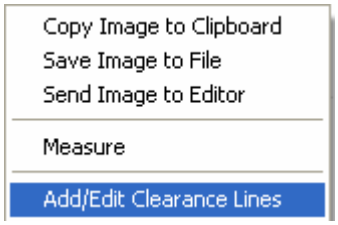
14. Select '0.415' kV from the *Show only Voltage* list, ensure *Use Standard Conductor Mappings* is checked and click *Continue*.

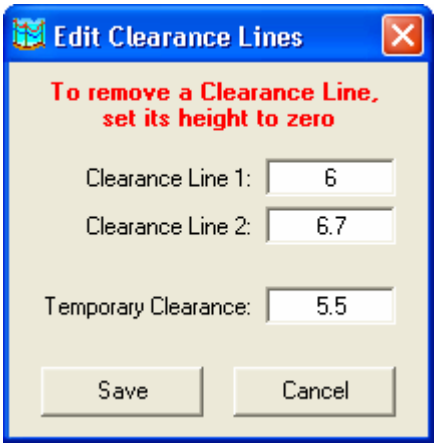


15. The profile now has the following appearance:



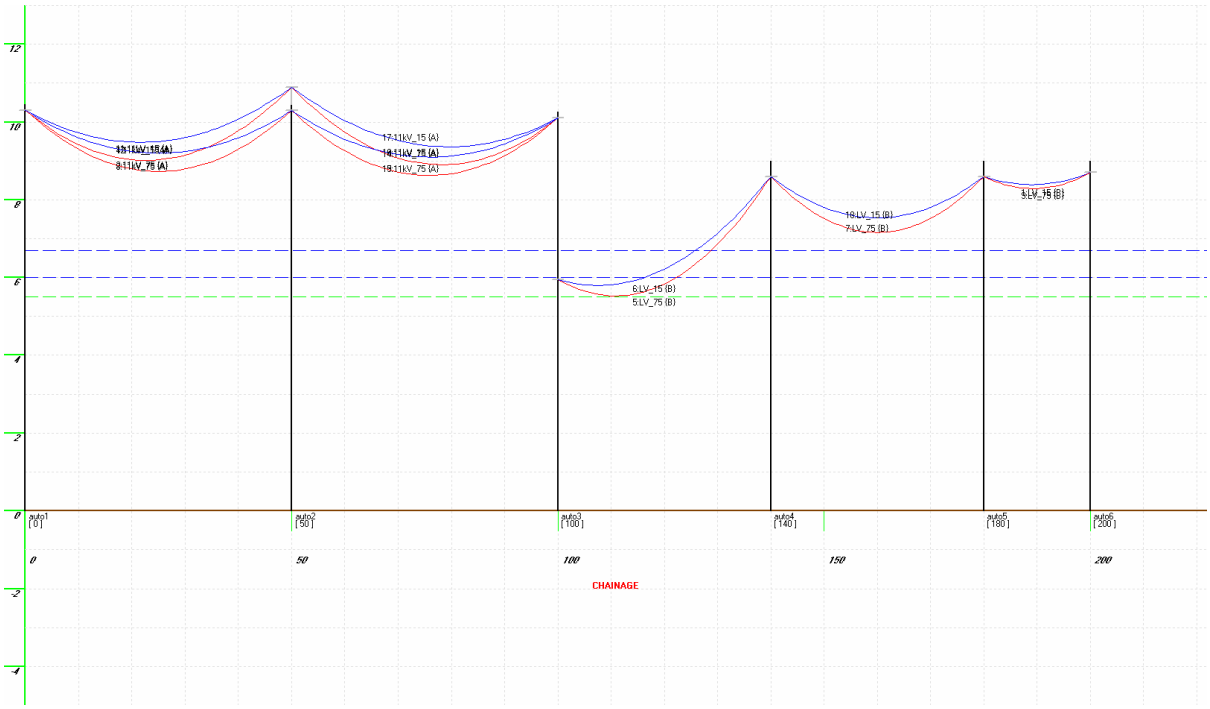
16. Now right click on the *Profile* and choose *Add/Edit Clearance Line*, and enter '5.5' for the *Temporary Clearance* (5.5m is the required clearance for the LV to the ground). (It is clearly visible that all the 11kV meets the required minimum ground clearance of 6.7m.)



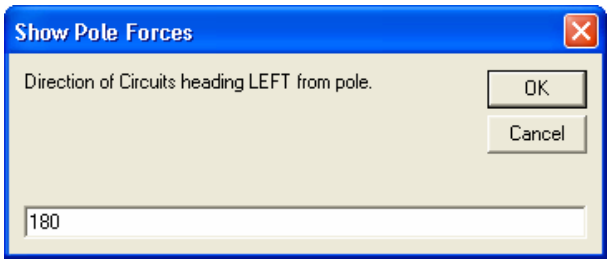


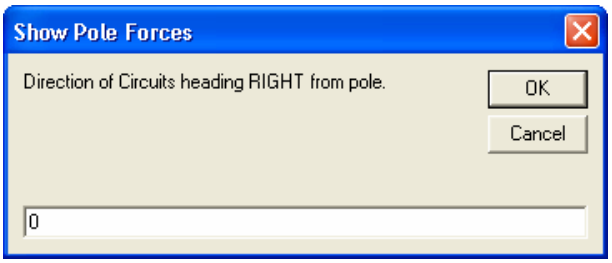
17. The profile now has the following appearance, the LV meets clearance as shown

by the green dashed line.

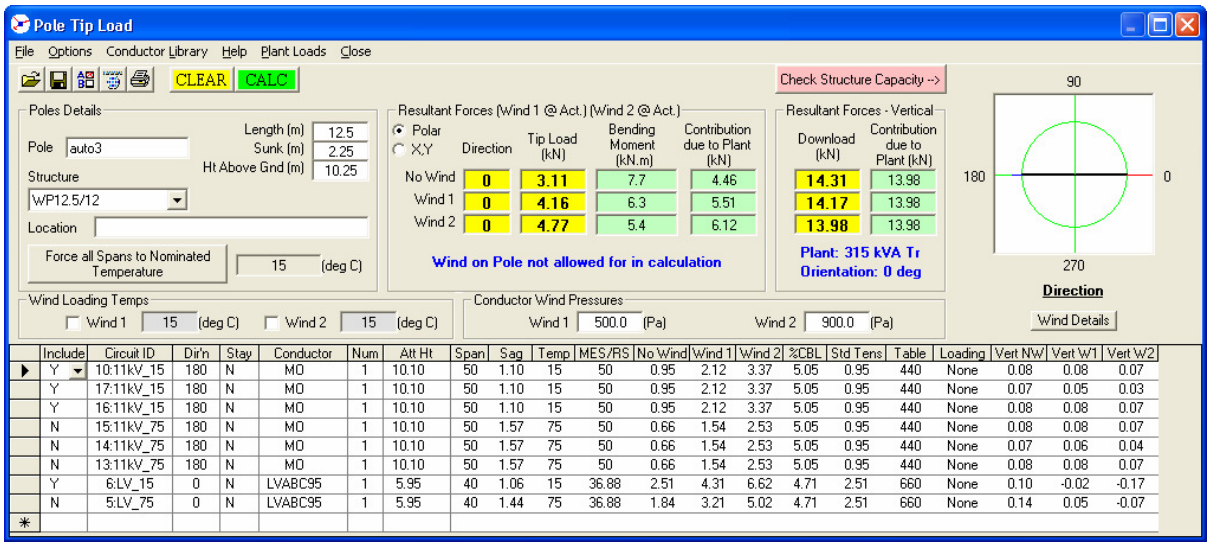


18. We now wish to check the forces on the transformer pole. We move the cursor over the pole and click on the right mouse button. We select the option *Show Pole Forces* from the pop-up menu. This links us to the *Tip Load* module where you will be prompted for the directions of the circuits heading left and right from the pole.

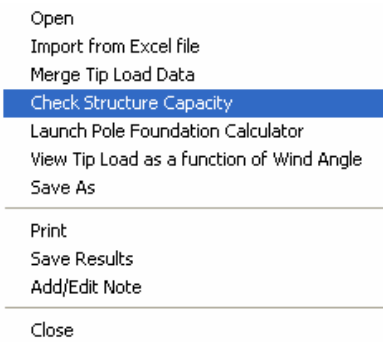


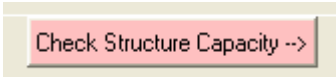


19. Enter 180 (degrees) for LEFT and 0 (degrees) for RIGHT and click *OK,* this will open the Tip Load module with all circuits on the pole pre-loaded. Click *Calculate* to determine the pole tip forces.

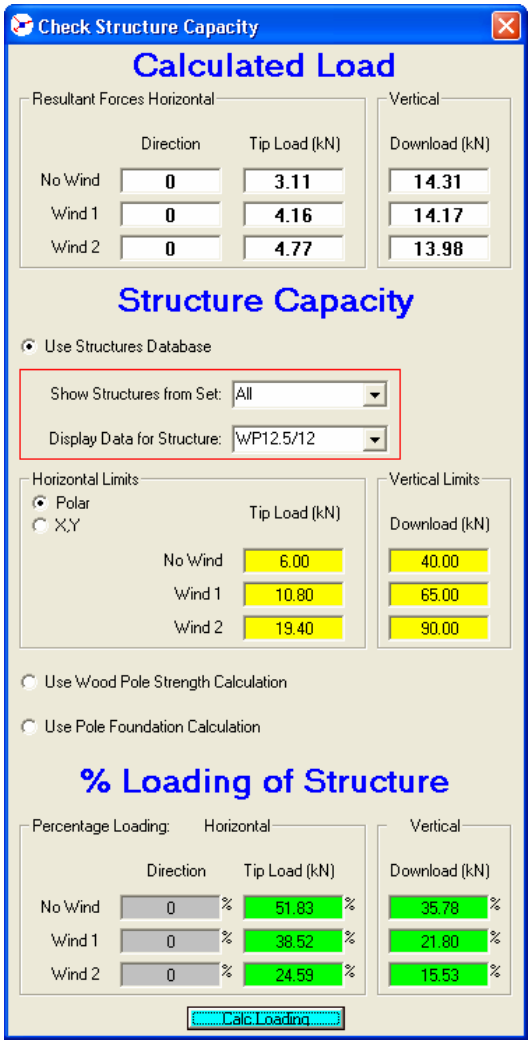


20. Now click on File -> *Check Structure Capacity* (or click on the *Check Structure Capacity* button), this will launch the *Check Structure* Capacity form and fill in the corresponding fields.





21. Click *Calc Loading* to display the *% Loading of the Structure*.



22. You may notice that the results are highlighted in green. This means that this structure is strong enough to take the *Calculated Load*.

NOTE: Although generous limits apply to entities (refer section 4.10), the time taken to redraw the profile increases with every addition, thus a trade-off between the size of profiles and the time taken to redraw the profile is needed. Take care not to generate unnecessary circuits and keep profile lengths reasonable (split into several profiles if needed).

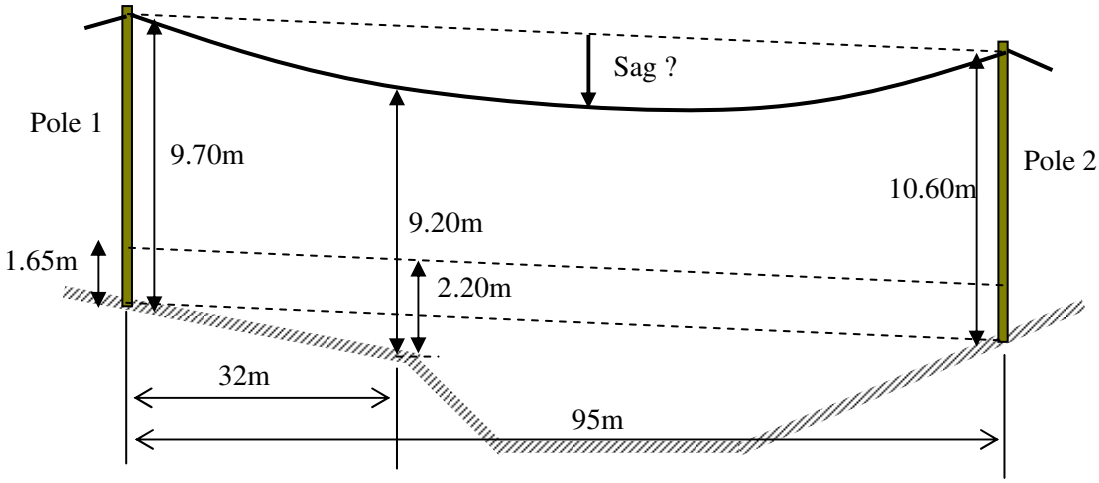
3.8 INTRODUCING THE SAG CALCULATOR

Example

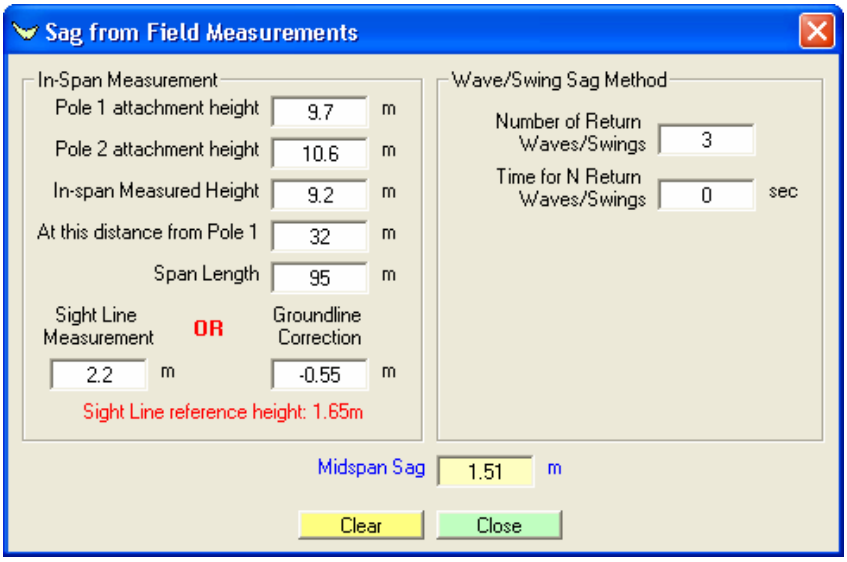
A 95m span of mains crosses a creek, as shown below. The sag in the span needs to be determined in order to check the forces on the aged poles either side.

It is not possible to obtain a measurement at the centre of the span because of the creek, but it is possible to measure on the creek bank on one side 32m into the span. Also, to compensate for the uneven ground, a sight line measurement is taken at this point.

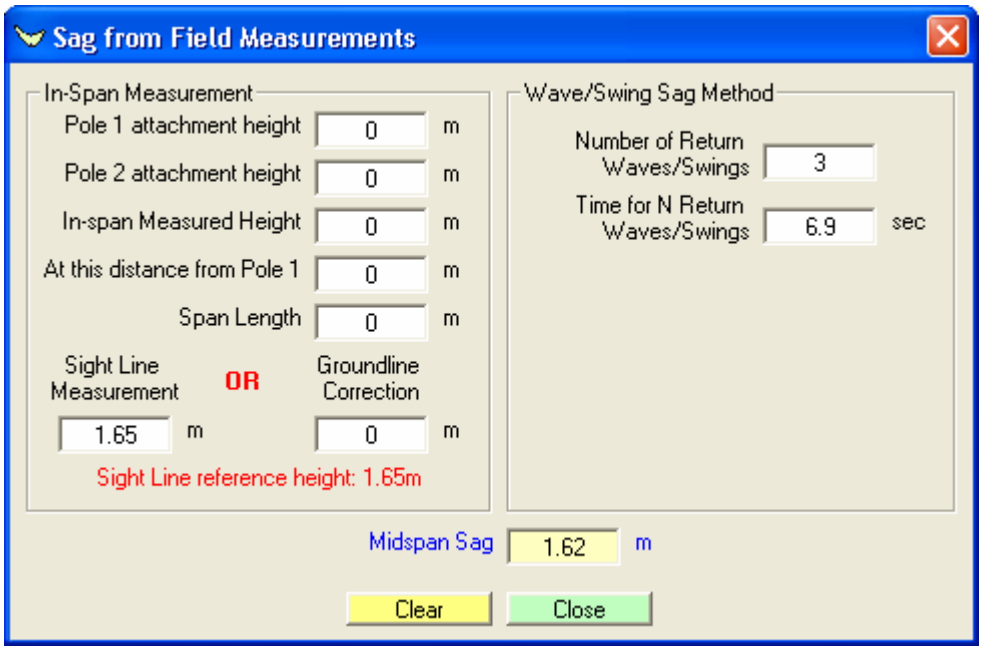
As a means of double-checking the measurements, wave sagging is used. The conductor is struck and the time for 3 wave returns is measured using a stopwatch.



Call up the Sag Calculator from the function menu and enter the height stick and sight line measurements as shown below. Notice that the 'dip' at the mid-span point is calculated to be 0.55m (= 2.20 – 1.65). The sag is calculated to be 1.51m.



We now wish to verify that this result is correct using the wave sagging times. The screen is cleared and data is entered as shown below, yielding a sag of 1.62m. This is slightly higher than, but similar to, the measured result and confirms the correctness of our measurements. Of course, wave or swing sagging is not as precise as conductor measurement.



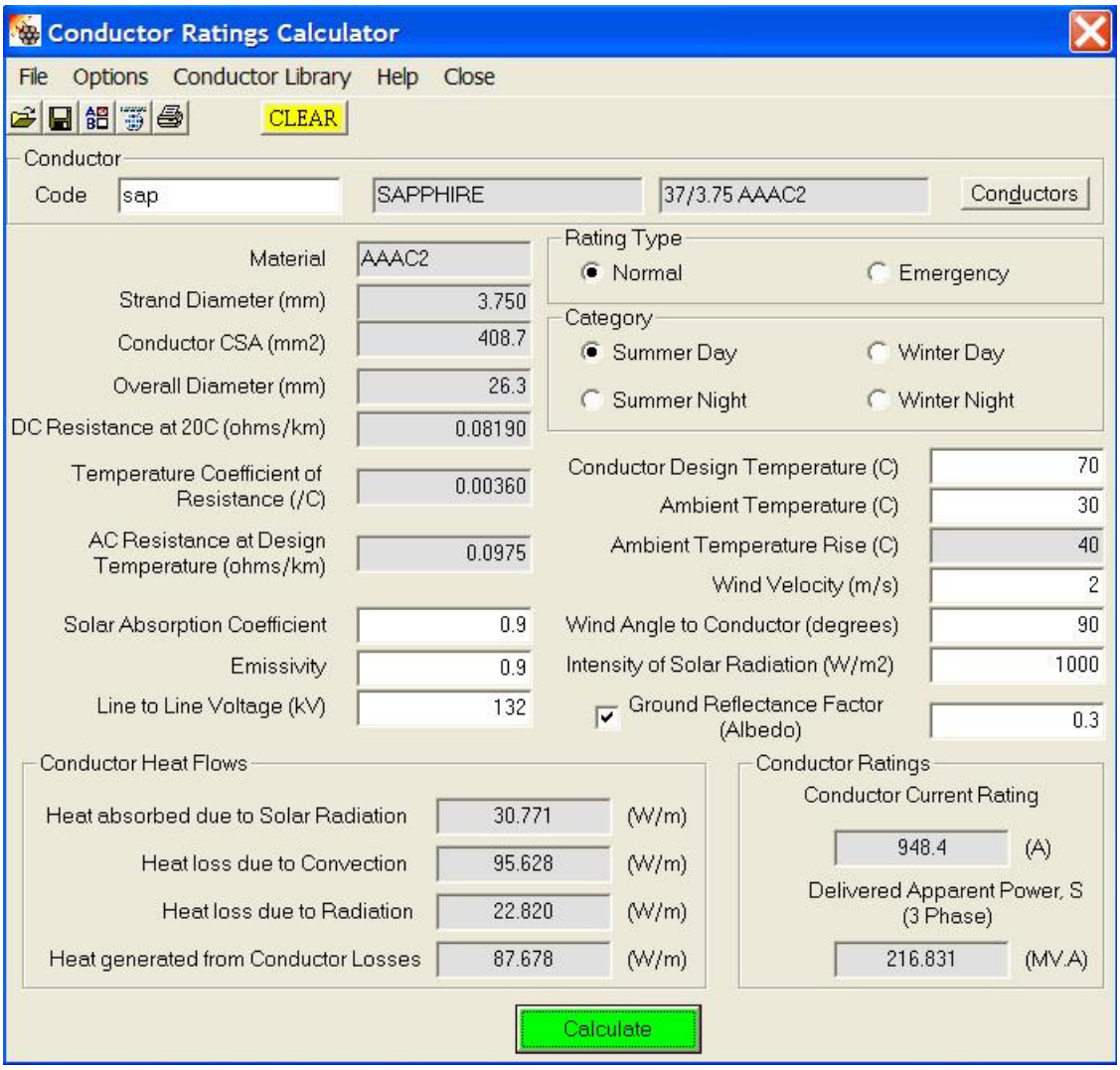
3.9 INTRODUCING THE CONDUCTOR RATING MODULE

Example

Determine the rating of SAPPHIRE conductor under the following conditions:

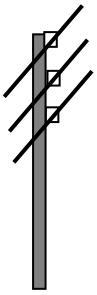
- 132kV line
- 2m/s wind normal to conductor
- 30°C ambient air temperature
- 70°C maximum operating temperature
- Day time 1000W/m^2 incident sunlight
- Albedo (ground reflectance factor) of 30%
- Blackened conductor – old line in polluted area

Open the *Conductor Ratings* module, enter conductor code 'SAP' and the various parameters as shown below, then click on the *Calculate* button.



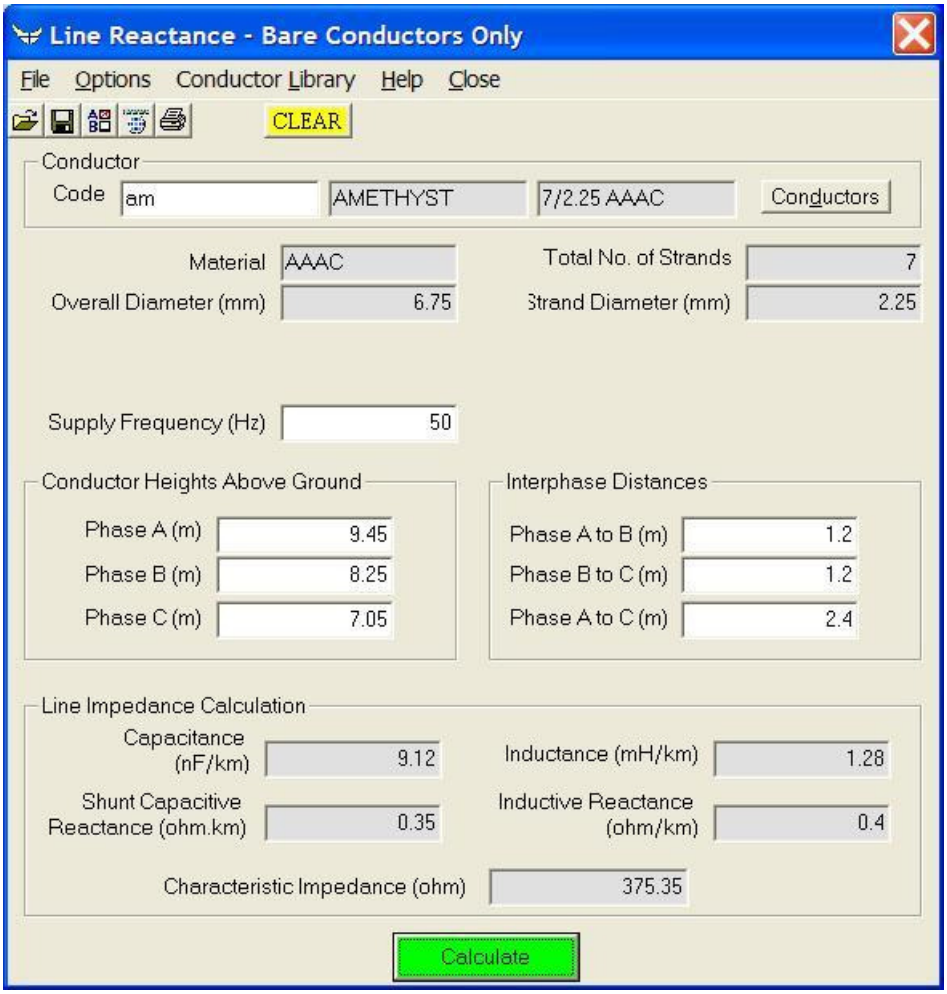
3.10 INTRODUCING THE LINE REACTANCE MODULE

Example



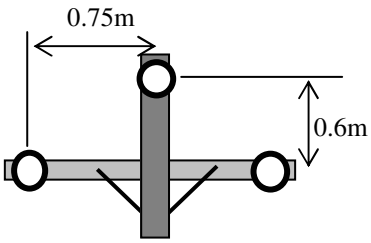
Determine the inductance and capacitance of a line with AMETHYST (7/2.25 AAAC) conductor, with the phases being spaced 1.2m apart vertically. The average conductor heights above ground are 9.45, 8.25 and 7.05m respectively.

Open the *Line Reactance* module, enter conductor code 'CH', spacings and average heights above ground as shown below, then click on the *Calculate* button.

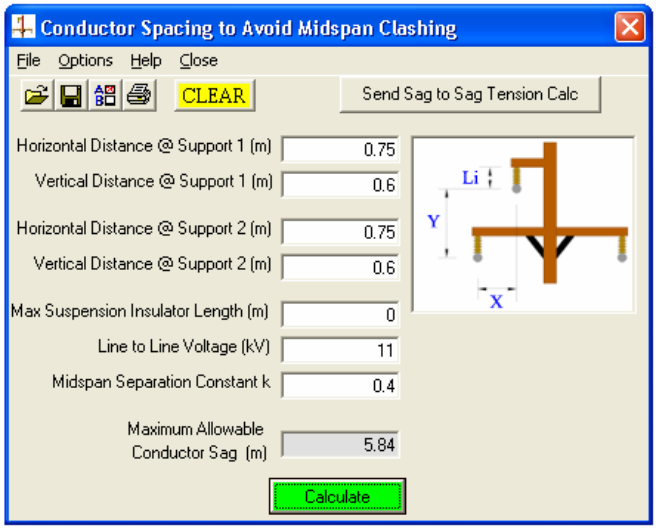


3.11 INTRODUCING THE CONDUCTOR SPACING MODULE

Example

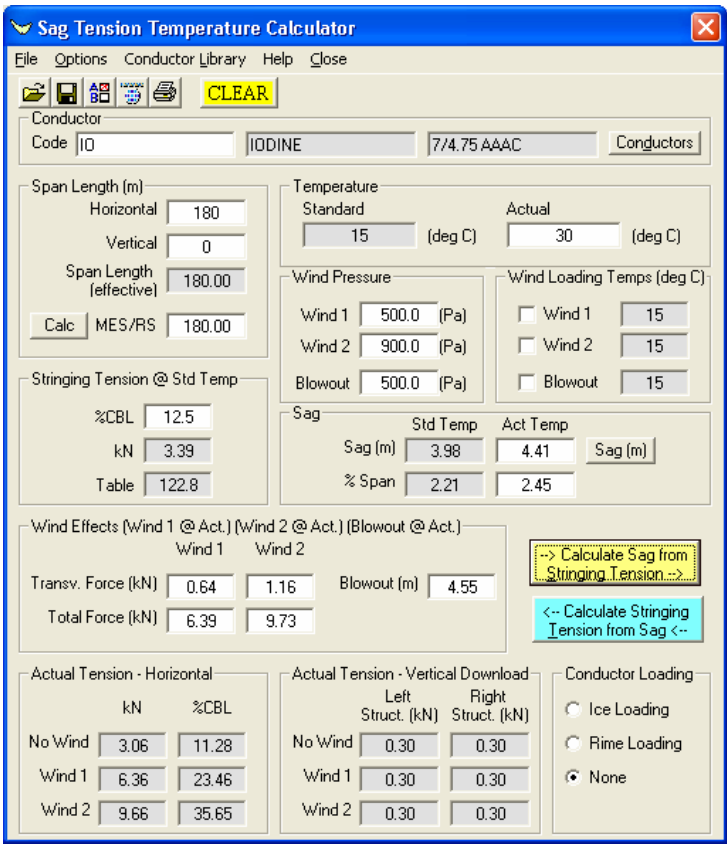


A 180m span of 11kV line is to be erected across a gully. IODINE conductor is to be used, strung at 12.5% CBL. Strain fittings are required at each end of the span. The standard strain construction is shaped as shown. Can this construction be used, or will a special construction be needed?



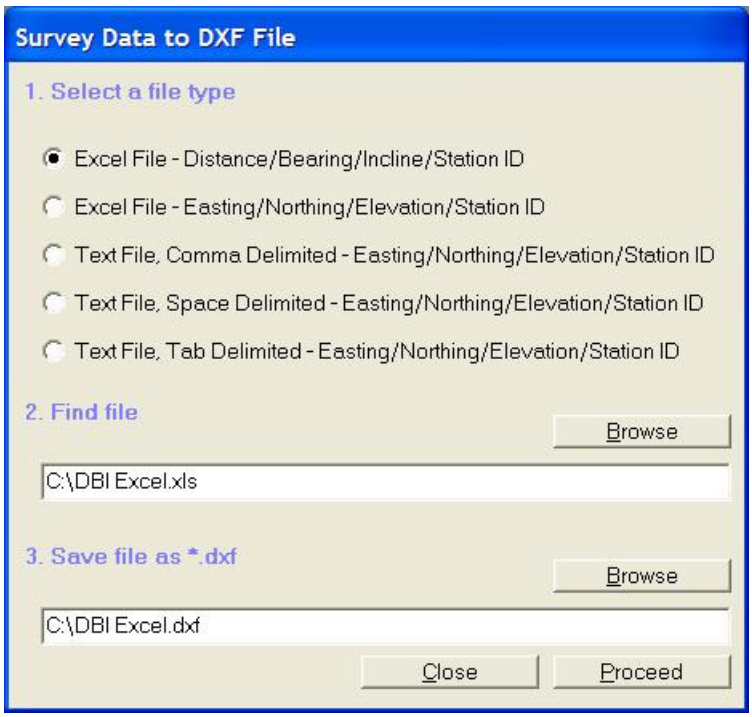
Open the *Conductor Spacing* module, enter the spacings as shown to the left. Set the free-swinging suspension insulator length to 0, as both ends are strain points that are rigidly fixed. Click on the *Calculate* button. The maximum allowable sag is 5.84m.

Using the *Sag-Tension-Temperature* module, with conductor code 'IO', span length 180, 12.5% CBL stringing tension, and actual temperature set to 30°C (because clashing is most likely to occur under windy conditions, which will also tend to cool the conductor) we note that the sag is 4.41m, which is less than the maximum allowable sag of 5.84m calculated above. Therefore the standard construction will be satisfactory.



3.12 Survey To DXF

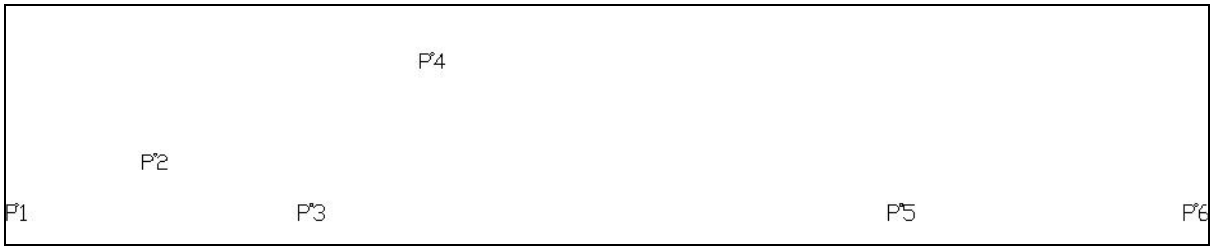
Under the *Functions* menu there is the *Survey To DXF* utility. This utility provides a means to convert simple Import files into an Easting/Northing Planview. It takes the Import files as described in section 9.2 and simply plots a little circle for each data point and annotates the Station ID next to it.



Example with Distance Bearing Incline File

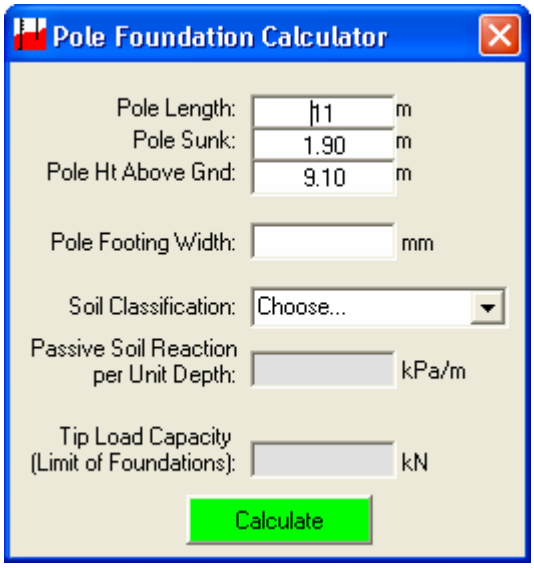
	A	B	C	D
1	0	10	50	P1
2	10	20	60	P2
3	20	0	70	P3
4	30	20	80	P4
5	60	0	120	P5
6	80	0	140	P6

The following diagram is the result (opened with Autodesk AutoCAD).



3.13 Pole Foundation Calculator

Under the *Functions* menu select the *Pole Foundation Calculator*. This is a simple calculator used to calculate the tip load capacity of a Pole.



Start by entering the *Pole Length* and sinking details. Then enter the *Pole Footing Width:*

- for Natural Backfill enter the average diameter of the pole below the ground, or
- for Full Concrete Foundation enter the diameter of the bored hole, or
- for Concrete Stabilised Soil enter the mean of the average diameter of the pole below the ground and the diameter of the bored hole.

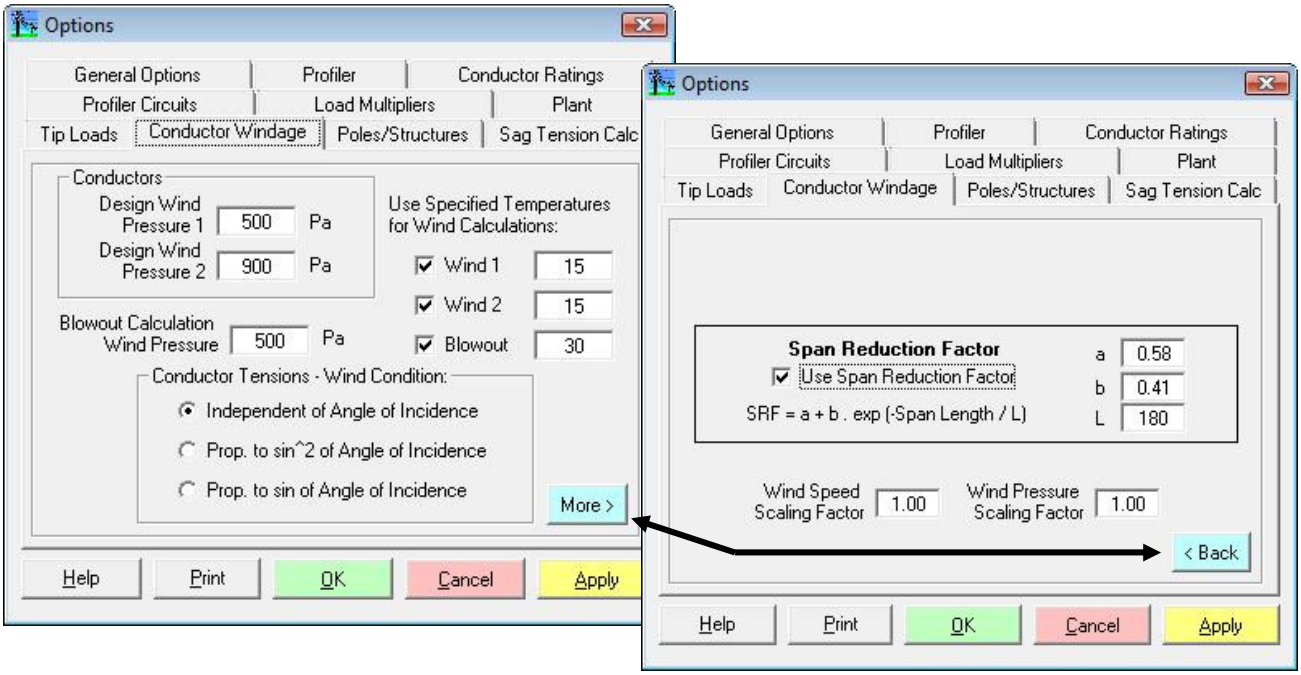
Next enter the *Passive Soil Reaction per Unit Depth* in metres of the soil or select the *soil classification* from the list (this loads the value from the *Soil Classifications DB* (refer section 17)).

Finally, click *Calculate* to calculate the pole *Tip Load Capacity (Limit of Foundations)* in kN.

Note: this result is the 'foundation limit' of the pole and is still subject to the 'strength limit' of the pole.

4. OPTIONS SETTINGS

4.1 Conductor Windage



Base Design Wind Pressures correspond to the practical worst-case wind pressures likely to be exerted upon the conductors. This will depend upon:
This will depend upon:

- recognized standards for wind loading and return period (e.g. 1 in 50 years is common for distribution lines under limit state design)
- the drag coefficient for the conductor, which depends on its size and roughness
- local weather patterns (e.g. cyclonic coastal area)
- the direction of the wind (e.g. across the line is worse than along the line).

Values in the range of 500 – 1900 Pa are typical.

PnW allows for two cases to be considered simultaneously.

Blowout Calculation Wind Pressure is the wind pressure to be used for conductor blowout (horizontal sag) calculations. A value of 500 Pa is typical.

Wind Loading Temperatures

The facility to enter standard temperatures for calculating Wind Loading is activated by checking the relevant checkboxes and entering the standard temperatures.

Whenever wind loads are calculated, if these options are set, then winds loads will be calculated for these temperatures instead of the *actual temperature* value.

If the Blowout checkbox is checked then the temperature entered is used for working out the amount of blowout that may occur on any circuit span (used when creating a Planview DXF of a Profile).

Wind Angle and Effective Wind Pressure

Three options are allowed for determining wind pressure on conductors as wind angle varies:

1. Independent of Angle of Incidence, i.e. assume wind is normal to each conductor, giving maximum wind conductor tensions regardless of wind direction. This gives results akin to simple hand calculations for pole tip loading, and tends to be very conservative.
2. Vary wind pressure according to the square of the sin of the incidence angle of the wind on the conductor. Thus, for a wind direction in line with the conductor (incidence angle equal to zero), the tension is merely the no wind tension in the conductor. Where the wind is normal to the conductor (incidence angle equal to 90º), the conductor tension is at a maximum. For wind at 45º to the conductor, the wind pressure will be $0.7071^2 = 0.5$ times the maximum wind pressure. This method is commonly used in Australia and New Zealand.
3. Vary wind pressure according to the sin of the incidence angle of the wind on the conductor. Thus, for a wind direction in line with the conductor (incidence angle equal to zero), the tension is merely the no wind tension in the conductor. Where the wind is normal to the conductor (incidence angle equal to 90º), the conductor tension is at a maximum. For wind at 45º to the conductor, the wind pressure will be $0.7071^2 = 0.5$ times the maximum wind pressure.

Use Span Reduction Factor (SRF). This feature may be used with transmission lines or very long spans on distribution lines (typically >200m). Checking this box reduces the base wind pressure as span length increases. This decrease is due to:

- the inertia of longer spans of conductor, and
- the fact that microbursts of wind may be quite localised and not at the same intensity over the entire span.

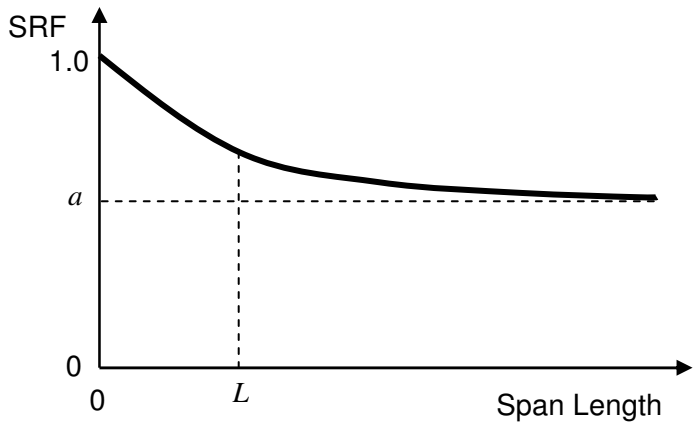
The SRF is multiplied by the Base Design Wind Pressures to determine the actual wind pressure to use for each span.

The program models the wind pressure as falling away exponentially. It uses the following equation for SRF:

$$SRF(l) = a + b \exp(-l / L)$$

where l is the actual span length, and a, b and L are user-supplied constants.

This is illustrated below.



For more information, refer Electricity Supply Association of Australia (ESAA) document HB C(b)1 "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" (1999 or later editions).

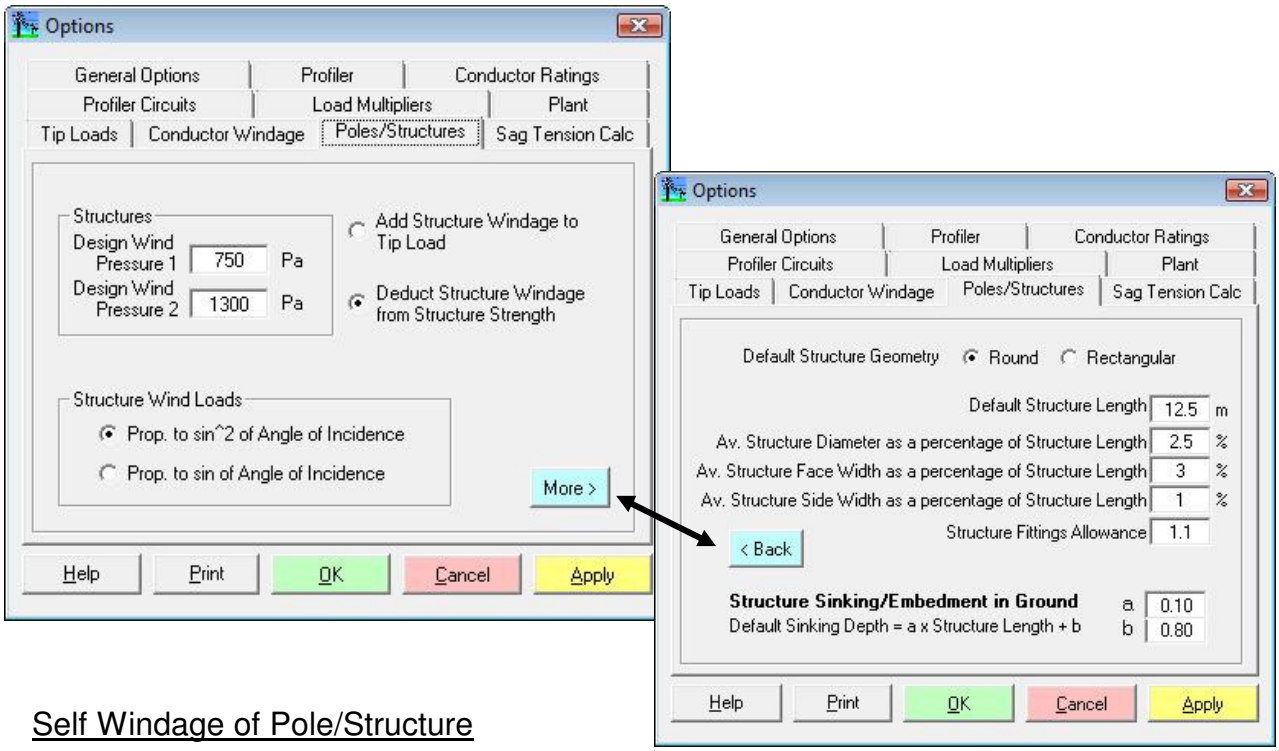
Wind Pressure Scaling Factor is used to scale the Wind Pressure where Pressure (Pa) is selected as the Wind Force Unit.

It can be used to apply coefficients for:

- terrain and any shielding
- various levels of security/reliability
- any drag coefficients
- the direction of the wind
- the air density.

Wind Speed Scaling Factor is used to scale the Wind Velocity where Velocity (m/s) is selected as the Wind Force Unit. It can be used to apply various coefficients as with Wind Pressure Scaling.

4.2 Poles/Structures



<u>Self Windage of Pole/Structure</u>

For distribution lines, the load due to wind on the pole/structure is comparatively small, typically only a couple of kilonewtons or so when referred to the tip.

Options for handling wind load applied to the pole, as used by various power authorities, are:

1. Include wind load in calculation of pole tip load, or
2. Derate pole capacity (strength) by an allowance for wind load, and consider only conductor forces when calculating tip loads.

For Option 1 above, the pole diameter/width, height above ground and poletop constructions/fittings allowance are taken into account in the Tip Loads module. For Option 2, these are taken into account in the Wood Pole Strength module.

Poles n' Wires allows for wind pressures on the sides of the structure to be proportional to either:

1. the square of the sin of the angle of incidence to the surface (commonly used in Australia and New Zealand), or
2. the sin of the angle of incidence.

This has particular relevance to poles with rectangular or square sections. Thus, when the wind is normal to the pole face, the applied force on the face is at a maximum, whereas when it is parallel to the face, it is nil.

Design Wind Pressures correspond to the practical worst-case wind pressures likely to be exerted upon the pole. This will depend upon:

- recognized standards for wind loading and return period (e.g. 1 in 50 years is common for distribution lines under limit state design)
- the drag coefficient for the pole, which depends on its shape (e.g. rectangular or round) and roughness
- local weather patterns (e.g. cyclonic coastal area)
- the direction of the wind.

Values in the range of 700 – 2500 Pa are typical.

PnW allows for two cases to be considered simultaneously.

Default Structure Geometry
The user can nominate round or rectangular section poles as the default.

Default Average Pole Diameter/Width can be specified as a percentage of Pole Length. The average pole diameter/width is the diameter of the pole midway between the ground and its tip. It is used to calculate the area on which the wind acts.

Poletop Fittings Allowance is a factor by which the projected pole area should be multiplied in order to allow for wind load on the cross-arms, insulators and other poletop fittings. A value of 1.1 is fairly typical for distribution lines.

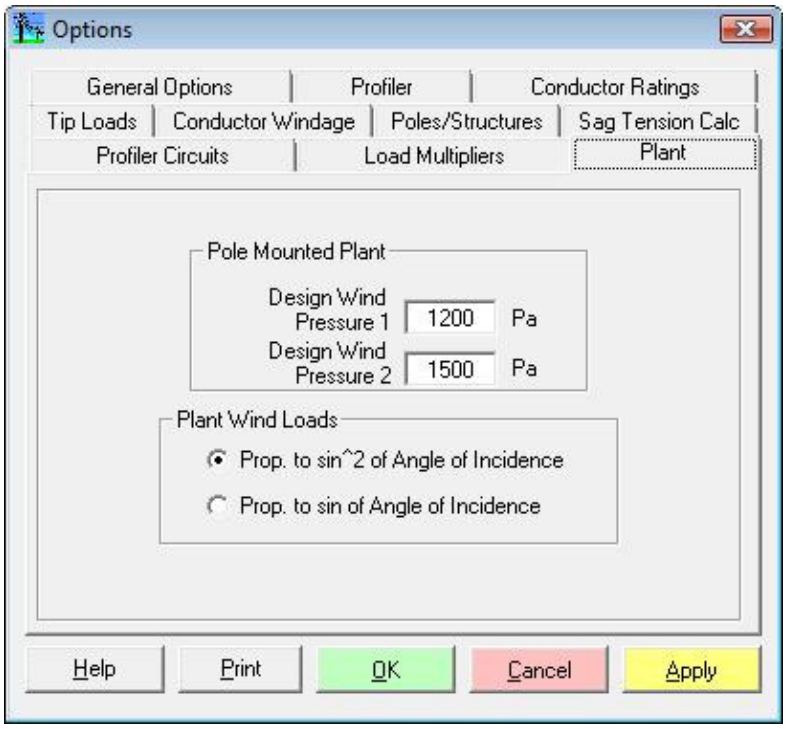
This factor may also be used to allow for pole taper. For instance, if *ground-line*, rather than *average*, pole diameter values are used when calculating pole windage, then this factor may be set to 1.0. This is because there is approximately 10% difference between average diameter and ground-line diameter on a typical timber distribution pole.

Sinking or Embedment Depth The user may nominate the default pole planting or Sinking Depth, S, as a function of the Pole Length L. The relationship is given by the following equation:

$$S = a\,L + b$$

where a and b are user-supplied parameters. a typically has a value of 0.1. b is a constant, typically in the range 0.6 – 1.0.

4.3 Pole-Mounted Plant



Design Wind Pressures correspond to the practical worst-case wind pressures likely to be exerted upon the plant. This will depend upon:

- recognized standards for wind loading and return period (e.g. 1 in 50 years is common for distribution lines under limit state design)
- the drag coefficient for the plant, which depends on its size and shape (e.g. rectangular or round, with or without cooling fins)
- local weather patterns (e.g. cyclonic coastal area).

Values in the range of 700 – 2500 Pa are typical.

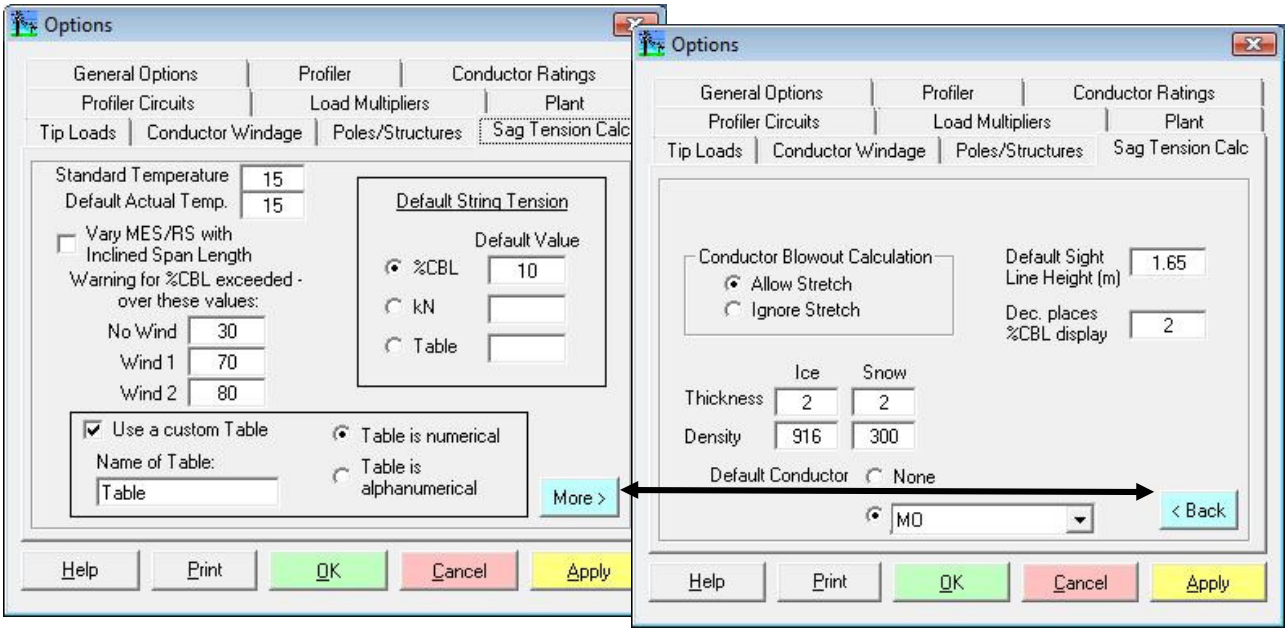
PnW allows for two cases to be considered simultaneously.

Poles n' Wires allows for wind pressures on the sides of the structure to be proportional to either:

1. the square of the sin of the angle of incidence to the surface (commonly used in Australia and New Zealand), or
2. the sin of the angle of incidence.

This has particular relevance to plant with a box-like rather than cylindrical shape. Thus, when the wind is normal to the plant face, the applied force on the face is at a maximum, whereas when it is parallel to the face, it is nil.

4.4 Sag-Tension-Temperature



Standard Design Temperature. This is a nominal base temperature, generally corresponding with the average winter temperature for the area. For mainland Australia, the standard design temperature is generally taken to be 15°C by default, although a number of utilities use 5°C. When a stringing tension is specified, it is taken to be at this temperature.

Default Actual Temperature. This is the default Actual Temperature for the module. Generally this will be set identical to the Standard Design Temperature. However, where the module is frequently used to back-calculate tension from measured sag, it may be preferable to use a nominal average ambient temperature.

Vary MES/RS with Inclined Span makes the MES/RS field in the Sag-Tension-Temperature module automatically track the inclined span length rather than the horizontal span length. Of course, users can alter the MES/RS value after they have entered span length.

Excessive Conductor Tension Warnings

The user may set levels for each load case in terms of percentage of conductor calculated breaking load above which the STT module will display results in red text as a warning.

Stringing Tables

Some supply authorities use various designations for their standard stringing tables rather than simply specifying tension as a percentage of CBL. For example, Energex use numeric stringing tables, where the number refers to the amount of sag in centimetres in a 100m span when strung at the nominated tension at 15ºC.

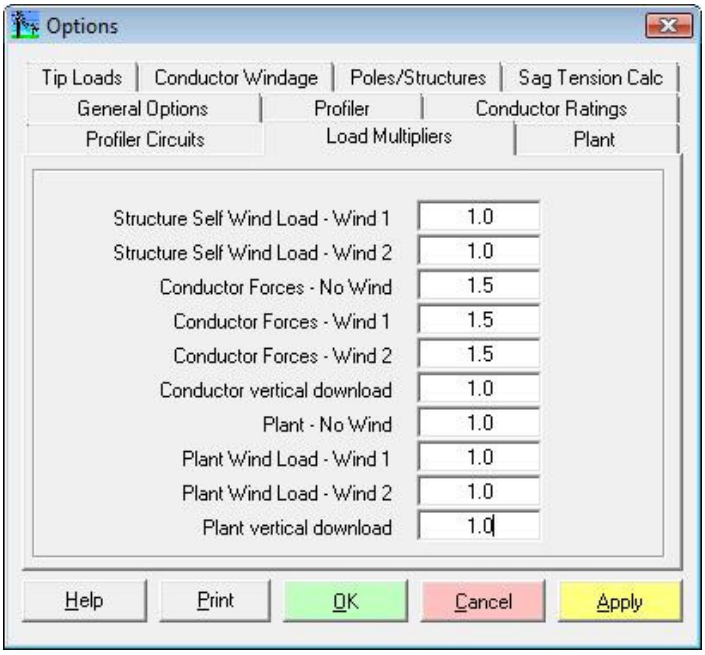
~~Conductor Blowout Calculation Method~~
~~When calculating the blowout the user can choose to allow/ignore conductor stretch.~~

Default Sight Line Height is used in calculating sag from conductor height measurements. It is the nominal eye height used when taking a sight line to determine whether the ground rises or falls mid-span relative to a line drawn between the pole bases.

Assumed Thickness and Density of Ice/Snow is used for calculating sag/tension/forces/blowout for conductors in cold locations with a coating of solid ice (density 916kg/m^3) or snow (or rime, a light frosty deposit with density 300kg/m^3).

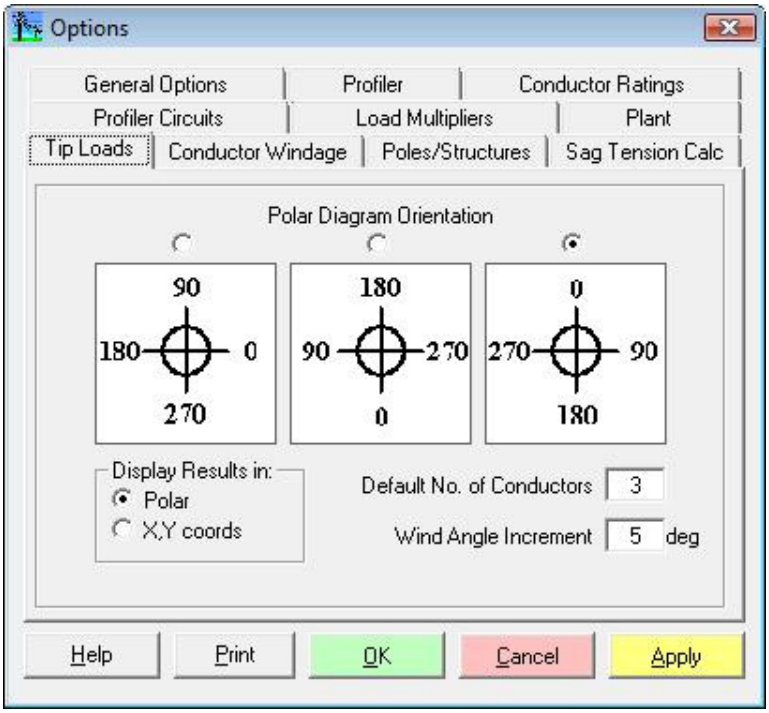
Default Conductor is used to **pre-load modules** with your most commonly used conductor type.

4.5 Load Multipliers



These multipliers are applied to the various forces applied by conductors as well as wind on structures and pole-mounted plant. They may be used to apply limit state equation coefficients, where required, or otherwise set to 1.0 when not in use.

4.6 Tip Loads



Orientation of Polar Diagram

There are three options for the orientation of the Plan Diagram of the pole displayed in the Tip Loads module. The user should select the option which best fits local practice, or with which he/she is most comfortable. The option shown on the right corresponds to a map and compass bearings. The option shown on the left may best appeal to users with a background in mathematics. The middle option is for users who like to take the direction of approach as 0°.

Polar/Rectangular

The user can choose for the Resultant Forces to be displayed in either Polar form (used with round poles or for determining stay orientation) or X,Y coordinates (for poles with rectangular cross-section). When in X,Y mode, the tip loads module gives the worst case forces in the X direction (0º) and the Y direction (90º)– it does not simply resolve the worst case polar value into X and Y components.

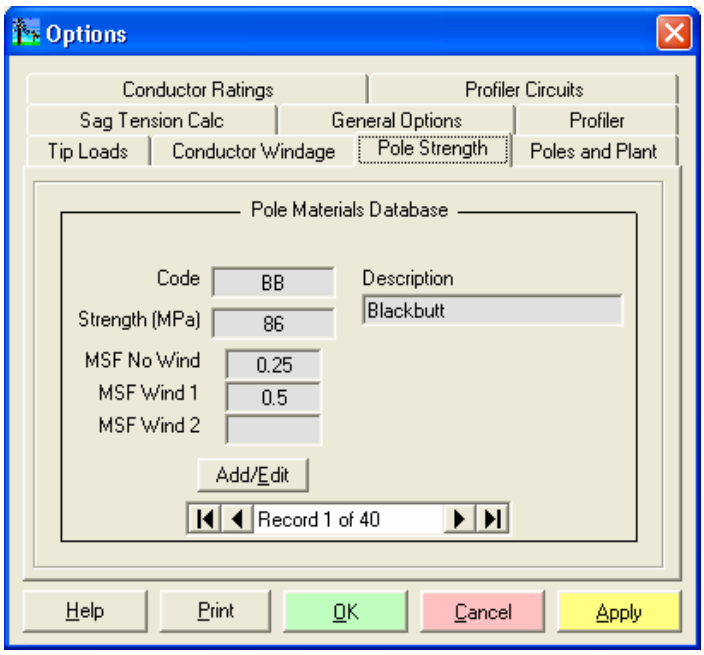
Default No. of Conductors

The user should also enter the default number of conductors in any circuit. This parameter is preloaded into the *Tip Loads* module, wherein it can be edited.

Wind Angle Increment

When performing a pole tip load calculation, the wind is applied from all directions between 0º and 360º, in steps of the size nominated here, and the worst case results noted and displayed. Increments of 5º or 10º are typical – this gives adequate accuracy and is not too onerous to calculate. Where precision is needed, 1º steps should be used.

4.7 Pole Strength Materials Database



Poles 'n' Wires is supplied with data for a number of timbers. These are listed according to species or strength group classification, each with its own Modulus of Rupture. You may peruse the list, stepping through the records one at a time, by clicking on the forward and reverse arrows of the data control.

The groups S1 – S7 are for unseasoned timbers; the groups SD1 – SD8 are for seasoned timbers. (Refer *AS/NZS 2878:2000 Timber – Classification into strength groups*.) Note that a 50MPa value for 'PI' pine is conservative.

Click on the *Edit* button, then the *Add* button to add a new conductor. A blank template will appear.

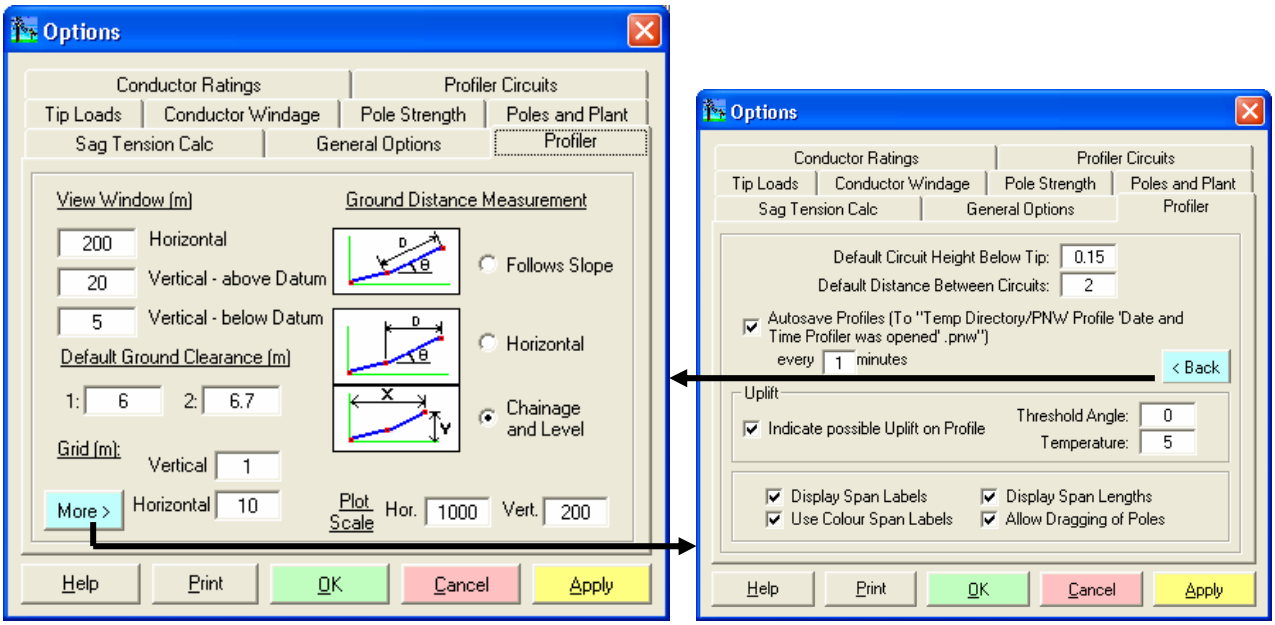
You may enter additional values, as follows:

- Enter a <u>unique</u> code (3 chars. maximum),
- a description of the material or timber species,
- its strength rating in MPa – either its ultimate strength, modulus of rupture or modulus of compression, according to the applicable failure mode
- the Material Strength Factors to use for 'No Wind', 'Wind 1' and 'Wind 2' load conditions. You may accept the default values, or enter values specific to the material. In practical terms, material strength factors are the inverse of a 'safety factor', and are designed to cater for variations in materials and other unknowns. Typical values are in the range 0.2 – 0.8.

After editing an entry, click on the *Refresh* button. To leave Edit mode, click on *Read Only*.

The *Delete* key allows you to remove materials that are not relevant.

4.8 Profile



Default View Window. This sets the scale of the screen display. The user may later adjust the default values used on opening up the *Profiler*. There is the facility to adjust:

- the chainage (horizontal scale) shown within the view window,
- the height (vertical scale) above the datum, and
- the height (vertical scale) below the datum.

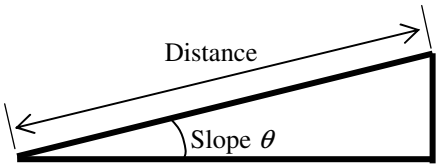
Default Ground Clearances. These clearance lines are drawn offset from the ground-line by the nominated distance, representing the minimum ground clearance the lowest circuit is required to have over the segment of ground. If the catenary curve crosses the line, there is insufficient height in the line, and the pole heights will have to be increased or the sag in the span reduced. Typical values range from 4.5 – 9.0 metres, depending on factors such as:

- the voltage of the line
- whether the line is insulated
- whether the line crosses a road or other area accessible to vehicles.
- Statutory requirements, or utility policy.
- whether heavy machinery is likely to be used nearby, eg. mining leases, cultivated land where harvesters pass below.

The user may alter the clearance from the default value from within the Profiler module.

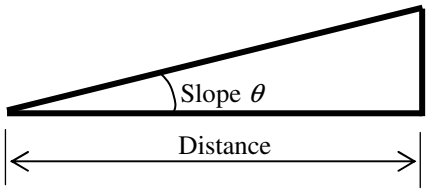
Default Grid Scale This is the interval, or number of metres, between grid lines. Grid lines make it easy to scale off the screen display. Typical values are 10m for horizontal and 1m for vertical.

Ground Line Data Format. This pertains to the way in which ground line data is to be entered. The top two options allow users to enter segments of ground, entering their length and slope in degrees. The top option assumes distance to be measured following the ground slope, eg as would be obtained if a trundle wheel were used.



$x = Distance \cdot \cos\theta$

The second option works with true horizontal distances for each segment. When slopes are small, the difference between these two methods is small.



The third option allows the user to plot points on the ground line section in terms of chainage (horizontal distance – *x* from the start of the section) and level (vertical height – *y* relative to the datum '0' line on the plot).

Plot Scale

These are the horizontal and vertical scales that will be used when a profile is printed and the user opts for a scaled plot. These scales are also used for exporting to a *dxf* file.

Default Circuit Height Below Tip

This is the default circuit height below the tip used in the Add Segment Form, this allows the user to enter the desired default distance below the tip.

Default Distance Between Circuits

This is the default distance between circuits used in the Add Segment Form, this allows the user to enter the desired default distance between circuits.

Autosave and Autosave Interval

The user can choose to have the program autosave profiles, and also choose the interval at which the program saves. Profiles are saved to *Temp directory/PNW Profile 'Date and Time Profiler was opened' .pnw*. If anything happens to the program and/or computer (ie computer crashes or power outage) then a profile may be recovered from the last save point.

Indicate Possible Uplift on Profile

This option displays a red letter U next to the span(s) that may have uplift in the *Profile* module. This is turned on by default.

Threshold Angle

The default method that Poles 'n' Wires uses to calculate potential uplift is to draw an imaginary line between the conductor point on the pole to a point 1.0m from the Pole, and then calculate the angle to the horizontal of this line. If greater than the nominated threshold angle a possible uplift condition is considered to exist.

Temperature

This value of conductor temperature will be used when determining if uplift exists and calculating the magnitude of uplift forces.

Display Span Labels

Provision is made to have circuit labels on the profile displayed or hidden. This can be altered later by the user from within the *Line* P*rofile* module. While display is useful for identification, the display can become cluttered when the scaling is compact.

Use Colour Span Labels

The user may choose to have circuit labels displayed in the same colour as the circuit curves—which makes for easy association of labels with curves—or in black text for improved visibility.

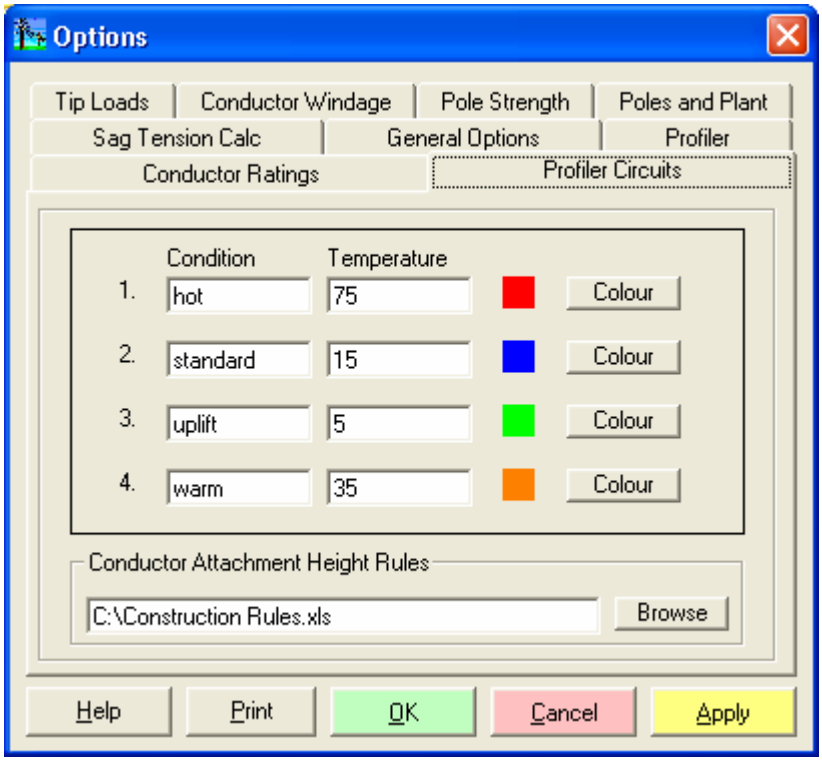
Display Span Lengths

Provision is also made to have span lengths on the profile displayed or hidden. While display is useful, the display can become cluttered when the scaling is compact.

Allow Dragging of Poles

Provision is made to turn on/off the dragging of poles. This is a useful aspect of the profiler that allows the user to drag a pole from one chainage to another. When this function is no longer required it is suggested that it be turned off, as the function will continue to drag poles when clicking on or around them.

4.9 Profile Circuits



This tab of *Options* refers to the standard circuit curves that are drawn in the *Line Profile* module when a Segment is entered. The user may set up to 4 default curves, assign them a condition name, which forms part of the circuit label, as well as a temperature and colour. The temperatures selected should take into account:

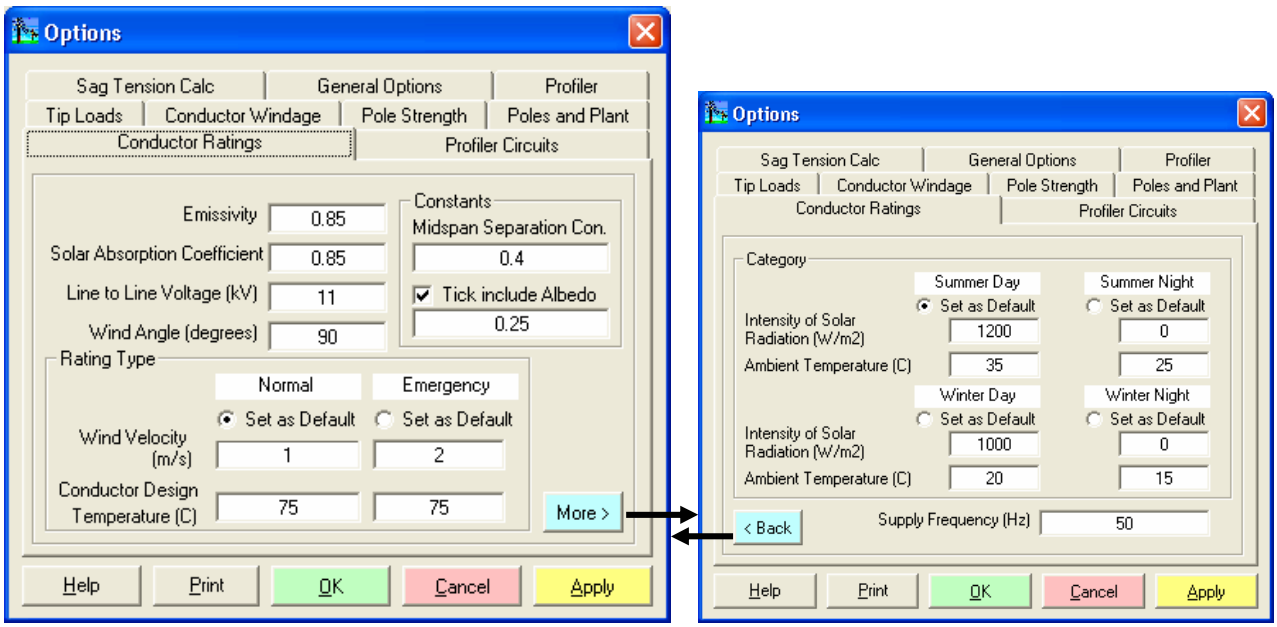
- local weather conditions
- any standards the network owner may have—many power authorities have standard temperatures and weather cases
- the ratings/properties of the conductors which are most commonly used.

<u>Conductor Attachment Height Rules</u>

An Excel File contained attachment spacing rules between constructions can be selected. These rules will be used in the *Pole/Structure and Associated Constructions Database* (refer section 9.3). The file must be in the format shown below:

	A	B	C
1	**Sub Circuit Construction**	**Super Circuit Construction**	**Spacing between Nominated Attachment Reference Points**
2	Construction_1	Construction_2	1.5
3	Construction_2	Construction_3	2.4

4.10 Conductor Ratings



Emissivity. This is a factor ranging from 0 – 1 according to how effectively a conductor radiates heat from its surface. For a shiny new conductor, the value is typically 0.3. For an old, blackened conductor, the value may be high as 0.9. Values in the range 0.6 – 0.85 are typical. Generally a worst-case condition is set, this being done in conjunction with the Solar Absorption Coefficient.

Solar Absorption Coefficient. This is a factor ranging from 0 – 1 according to how effectively a conductor absorbs heat at its surface. For a shiny new conductor, the value is typically 0.6. For an old, blackened conductor, the value may be high as 0.9. Values in the range 0.8 – 0.85 are typical. Generally a worst-case condition is set, this being done in conjunction with the Emissivity.

Line to Line Voltage (kV). This is used for calculating the MV.A rating of the conductor.

Wind Angle (degrees). This is the angle of the wind to the conductor. When set to 90, the wind is at right angles to the line. When set to 0, the wind is in the same direction as the line.

Albedo is reflected heat that strikes the line. The value entered is the ratio of the reflected heat to direct incident solar radiation.

Midspan Separation Constant is a value used for calculating the required conductor spacing at poles to ensure that mid-span clashing does not occur. A value of 0.4 is typical. Increasing this constant means that greater spacing is required between conductors to maintain the same maximum allowable sag.

The user may select a ‘Normal’ or ‘Emergency’ rating as the default condition. The following parameters may be set for each condition:

Wind Velocity (m/s). Even a small amount of wind has a sizeable effect on the rating of the conductor. This value will depend upon local weather conditions. (A wind speed in km/h may be divided by 3.6 to convert to a value in m/s.)

Conductor Design Temperature (°C). This will depend upon the conductor properties and any policies of the network owner. For bare aluminium conductors, the maximum design temperature is frequently set to 75°C. However, slightly higher temperatures may be permitted under emergency conditions. The higher the temperature, the more quickly the conductor will lose tensile strength (partial annealing).

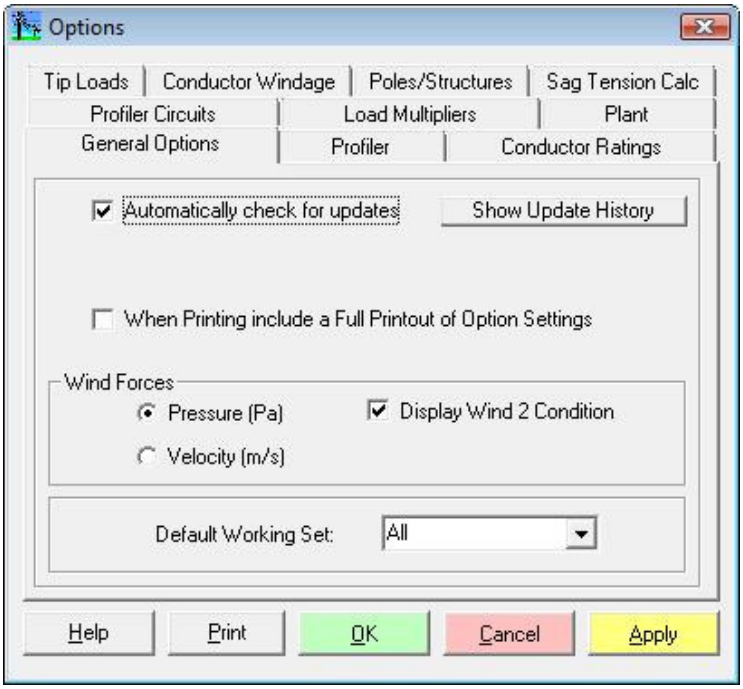
The user may select a ‘Summer Day’, ‘Summer Night’, ‘Winter Day’ or ‘Winter Night’ rating as the default condition. The following parameters may be set for each condition:

Incident Solar Radiation (W/m2). This will depend upon the latitude of the line. Values of 1000 are typical for daytime ratings, 0 for night ratings.

Ambient Temperature (°C). This is the ambient air temperature, and will vary according to the location of the line and the season.

Supply Frequency (Hz) is used in calculations of line reactance.

4.11 General Options



The user may choose to allow *Poles 'n' Wires* to *Automatically check for updates*. Upon launching *Poles 'n' Wires*, a check will be made to see if there are any update(s) to the program. If update(s) are available, then they will be downloaded automatically and a message will be displayed.

The *Show Update History* button displays an overview of installed updates.

The user may opt to have all printouts produced by the program accompanied by a full printout of options settings. This is useful for verifying that the program has been correctly configured.

The user may also choose the units for Wind Forces, either Pressure (in Pascals) or Velocity (in metres/second).

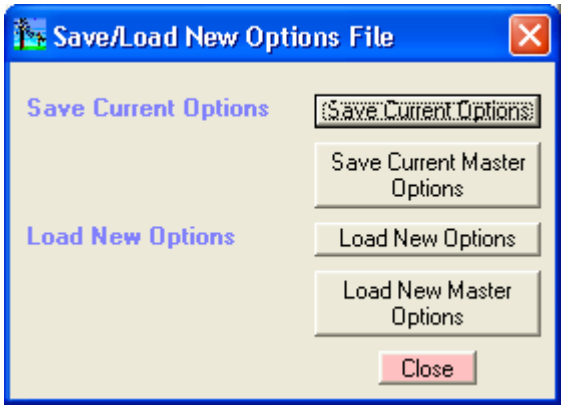
Where a second wind load case is not required, users may choose to leave the *Display Wind 2 Condition* box unchecked.

The Default Working Set may also be selected. Every Conductor, Conductor Material, Construction, Pole Mounted Plant, Structure, Pole Species and Soil Classification can be allocated to a set in the particular form. The Working Set selected will be used to filter this data in selected modules.

4.12 Save/Load Settings

Under the *Options* menu, select *Save/Load New Settings*. This form allows the user to:

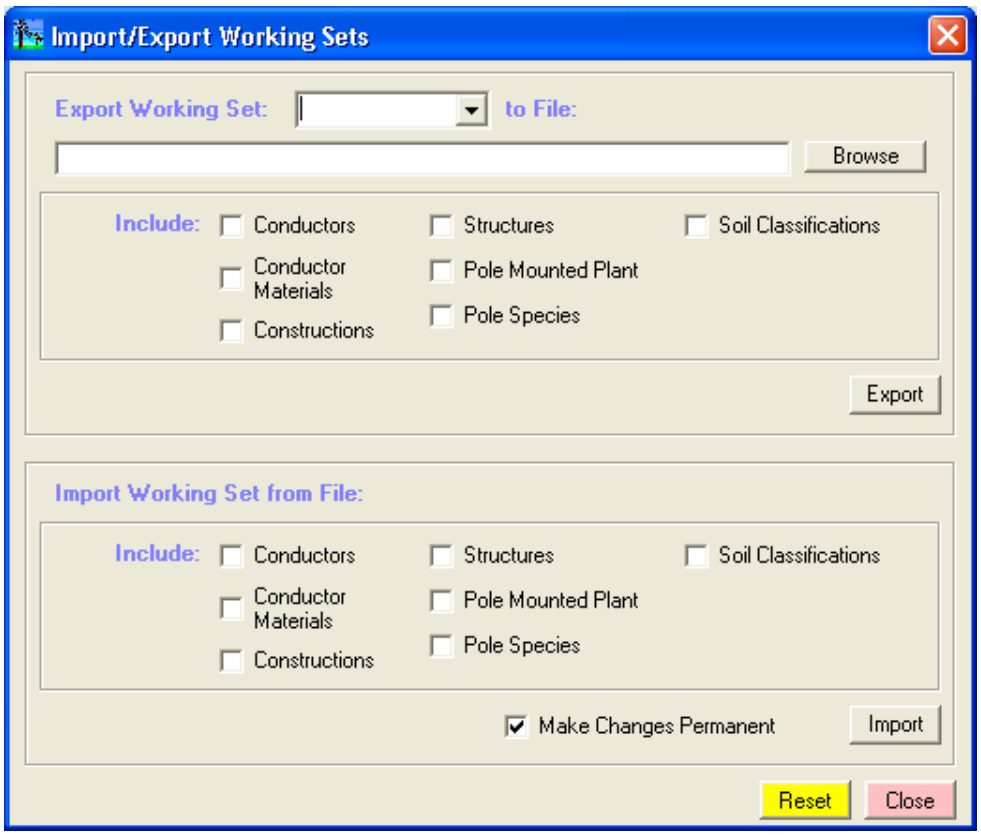
- *Save Current Options* – this saves the current options to a text file. This file can then be distributed.
- *Load New Options* – this loads new options from a text file. This allows for different option settings for different authorities.
  It makes a backup before overwriting the current options.



4.13 Import/Export Working Set Data

Under the *Options* menu, select *Import/Export Working Set Data*. This form allows:

- *Import Working Sets* – this allows the user to select which data from the saved text file to import. It also allows the user to add these values permanently to their database.
- *Export Working Sets* – this allows the user to select the *Working Set* (or all) as well as which data they wish to save and saves them to a text file.



4.14 Limits on Entities

The limits on entities are as follows:

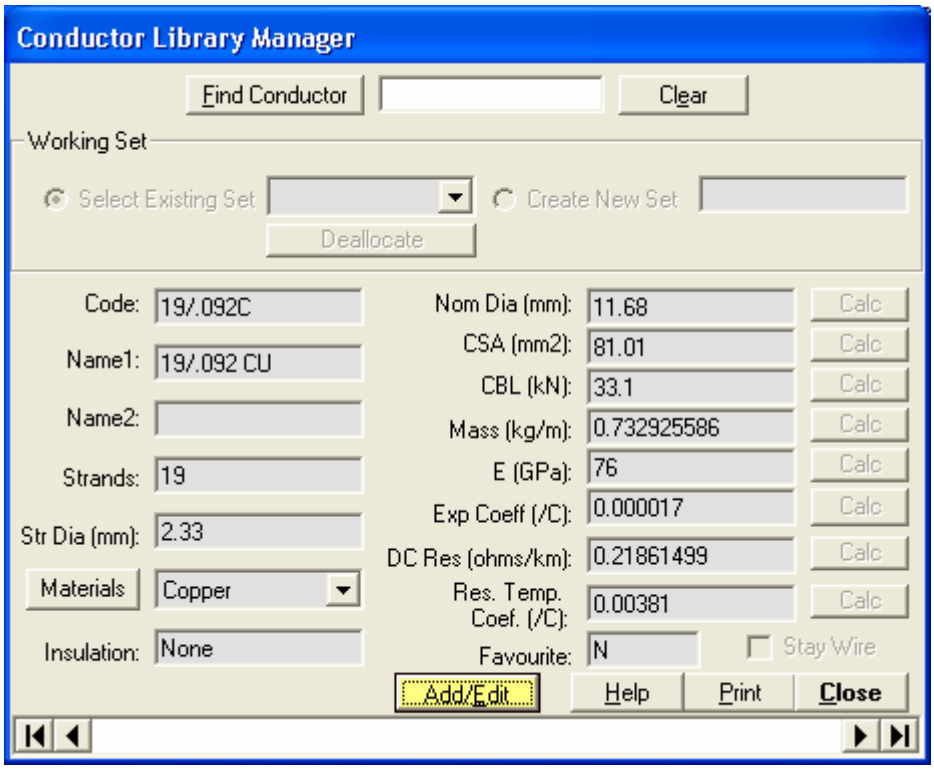
Maximum number of Circuits	500
Maximum number of Poles	100
Maximum number of Ground Line Points	2000
Maximum number of Segments	100
Maximum number of Annotations	200
Maximum number of Constructions on a Pole	10
Maximum number of Construction Attachment Points	12

If demand for any of the above Entities exceeds current limits, please email PowerMation and advise us of your requirements.

NOTE: Although generous limits apply to entities, the time taken to redraw the profile increases with every addition, thus a trade-off between the size of profiles and the time taken to redraw the profile is needed. Take care not to generate unnecessary circuits and keep profile lengths reasonable (split into several profiles if needed).

5. CONDUCTOR DATABASE

5.1 Finding a Conductor within the Database



You may step forwards or backwards through the database one conductor/cable record at a time using the forward and backward arrow keys in the data control at the base of the screen. The outer arrows enable you to move to the first or last conductors within the database.

Alternatively you may enter the code of the conductor you are searching for in the input box and click on the *Find Next* button to go to a particular conductor with a code name matching that typed within the input box. For example, if we type “M” in the input box and then *Find Next*, the database record for “MA” will be displayed. Clicking on *Find Next* again, we then move to records for “MAN”, “ME”, “MI”, and “MO”.

If you are uncertain of the conductor code, use the facility in the *Sag-Tension-Temperature* module to list conductors by material type.

5.2 Conductor Parameters

Working Set The set that the conductor is a member of, eg 'SET 1'. Select an existing set from the dropdown menu, create a new set or click on deallocate to remove an existing conductor from a set. (OPTIONAL)
Code A short, unique identifier for the conductor, eg 'MO'. (MANDATORY)
Name 1 The name by which the conductor is commonly known, eg 'MOON'.
Name 2 An alternate name or description for the conductor, eg '7/4.75 AAC', if needed.
For ACSR conductors, Name 2 should indicate the stranding in one of the following formats:

- '6/1/3.00' to indicate 6 strands of aluminium, 1 strand of steel, all strands 3.00mm diameter
- '6/4.75+7/1.60' to indicate 6 aluminium strands of diameter 4.75mm plus 7 steel strands of diameter 1.60mm.

Strands The number of strands in a conductor, eg '7'.
Str Dia Strand Diameter in millimetres, eg '4.75'.
(For conductors such as telecommunications cables or where strand sizes vary, you may wish to leave the two fields above blank, or enter 1 strand of a diameter equal to the overall diameter.)

Material The material the conductor is made from – select from the drop-down menu:

- AAC — All Aluminium Conductor
- AAAC — All Aluminium Alloy Conductor
- AAAC2 — All Aluminium Alloy Conductor – high strength, reduced conductivity
- ACSR — Aluminium Conductor Steel Reinforced – low steel/aluminium ratio
- ACSR2 — Aluminium Conductor Steel Reinforced – high steel/aluminium ratio
- AACSR — Aluminium Alloy Conductor – Steel Reinforced
- Copper — Hard-drawn copper or cadmium copper
- Steel — Galvanized steel
- ADSS — All dielectric self-supporting (fibre optic)
- Other

Where a cable is supported by a catenary wire, nominate the catenary material.
(You may create a new material type by clicking on *Materials* – refer later this section.)
(MANDATORY).

NOTE: New Materials may not be supported by some modules.

Insulation Enter 'None' if bare conductor, or insulating material, eg 'PVC', 'XLPE', 'HDPE'. (MANDATORY)

Favourite Enter 'Y' if the conductor is one that you will use frequently; otherwise enter 'N'. Favourites are listed before others in conductor lists. (MANDATORY)

Nom. Dia. The nominal, or projected diameter of the entire conductor or cable in millimetres. The *Calc* button enables you to estimate diameter based upon the number of strands and strand diameter, eg for a 7 strand conductor, the nominal diameter of the conductor is 3 times the strand diameter. A small allowance is added if the conductor is insulated. (MANDATORY)

CSA The Cross-Sectional Area of the conductor in mm^2. Where a cable is supported by a catenary wire, nominate the cross-sectional area of the catenary only. The *Calc* button enables you to estimate CSA based upon the number of strands and strand diameter. (MANDATORY)

CBL The Nominal/Calculated Conductor Breaking Load, Minimum Breaking Load, or Ultimate Tensile Strength of the conductor expressed in kN. (Values in kilograms force [kgf] may be converted to kN by multiplying by 0.00980665.) Where a cable is supported by a catenary wire, nominate the CBL of the catenary only. The *Calc* button enables you to estimate CBL based upon the CSA and the conductor material. (MANDATORY)

Mass The unit mass per length of the entire conductor or cable in kg/m. The *Calc* button enables you to estimate mass based upon the CSA and the material. (MANDATORY)

E The modulus of elasticity for the conductor (or catenary), in Pascals. The *Calc* button enables you to estimate E based upon the material. (MANDATORY)

Exp. Coeff. The linear expansion coefficient for the conductor (or catenary), in units of per °C. The symbol α is also used commonly for this parameter. The *Calc* button enables you to estimate the expansion coefficient based upon the material. (MANDATORY)

DC Resistance This is the DC resistance at 20°C, in ohm/km Note that the AC resistance is only slightly larger than the DC resistance for bare conductors. It will not be possible to enter values for telecommunications cables, optical fibres etc.

Temp. Coeff. This is the temperature coefficient of resistance in units of per °C. This is the amount by which resistance increases with increasing temperature. It will not be possible to enter values for telecommunications cables, optical fibres etc.

Stay Wire Check the checkbox if the conductor can also be used as a Stay Wire.

NOTE: Users should review the properties of conductors that they will use in any studies and ensure that the parameters listed in the database are consistent with the conductors being purchased for the project.

5.3 Editing Conductor Parameters

Scroll through the list of conductors until you locate the record you wish to edit. You may alter any of the parameters listed for the conductor. Click on the *Edit* button and modify the data as required. To leave Edit mode, click on *Read Only*.

5.4 Deleting a Conductor

Scroll through the list of conductors until you locate the record you wish to delete. Click on the *Edit* button, then the *Delete* button to delete the conductor currently being displayed from the database. To leave Edit mode, click on *Read Only*.

5.5 Adding a Conductor

Click on the *Edit* button, then the *Add* button to add a new conductor. A blank template will appear.

Enter the various parameters, as described above, including an identifying code for the conductor. Some fields are mandatory, as indicated above; others are optional. Click on *Update* to save the new conductor. When entering a new conductor, it is recommended that you have all the necessary conductor data from the manufacturer, relevant standard or power authority on hand. If you do not have all the necessary data, the program can help you estimate or calculate some of the parameters.

To leave Edit mode, click on *Read Only*.

5.6 Print Conductor Library Report

Click on *Print* to print a Conductor Library Report. A report containing all the Conductor information in table format will be created in an Adobe Acrobat File on the Desktop. If Adobe Acrobat software is not installed and internet access is available, then the user can click on the link to the Adobe website and download the free software.

5.7 Adding/Editing Conductor Material Parameters

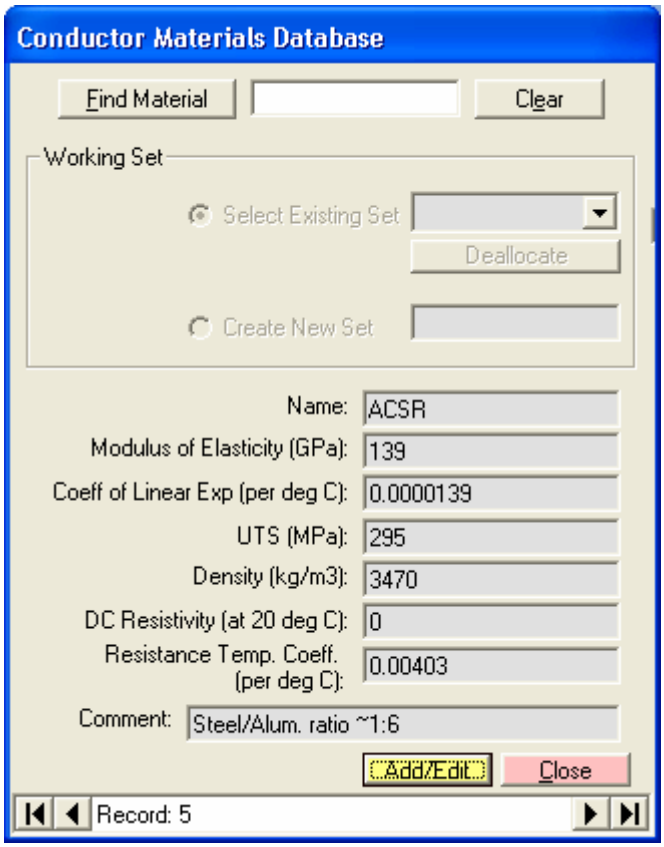
Click on the *Edit* button, then the *Materials* button. This allows you to edit or add to the Conductor Materials database. The properties for each class of materials are displayed and may be edited, or new materials added. These values are used when calculating conductor parameters for new conductors being entered into the database and are also taken into account where values are material specific (ie Conductor Ratings Module (refer section 11)). Of course, properties for individual conductors may simply be entered if known without using the internal calculator.

Note that for AAAC conductors, properties vary according to the precise alloy of aluminium used. If warranted, you may wish to create a material type for each alloy. The program is supplied initially with two classes of aluminium alloy:

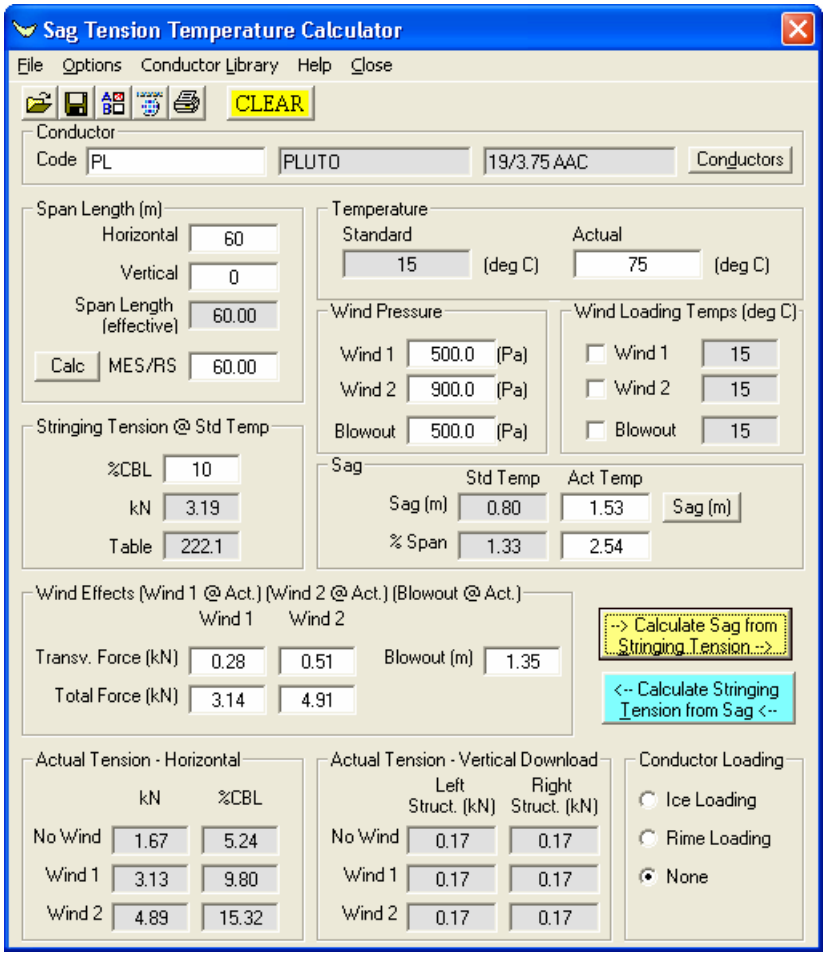
- AAAC – equivalent to alloy 1120
- AAAC2 – equivalent to alloy 6201, which has higher strength than 1120, but lesser conductivity.

Similarly, for ACSR, the properties will depend upon the ratio of steel to aluminium. The program is supplied initially with three classes of ACSR:

- ACSR – low steel content
- ACSR2 – high steel content – greater strength but reduced conductivity
- AACSR – aluminium alloy conductor with steel reinforcing.



6. SAG TENSION TEMPERATURE MODULE



6.1 Conductor Selection

When the user enters a valid unique conductor code, the program will display the conductor names. If uncertain of the conductor code to enter, click on the *Conductors* button to activate the window shown below.

Now either:

(i) enter a partial match to the code into the input box, or

(ii) select the conductor material from the drop-down list and check the box to indicate whether the conductor is insulated or bare. (Note: If searching for an ACSR conductor, you should look through conductors in categories 'ACSR' and 'ACSR2', which have different aluminium/steel ratios, as well as 'AACSR', aluminium alloy with steel. Similarly, two types of AAAC have been allowed for, depending upon the class of alloy.)

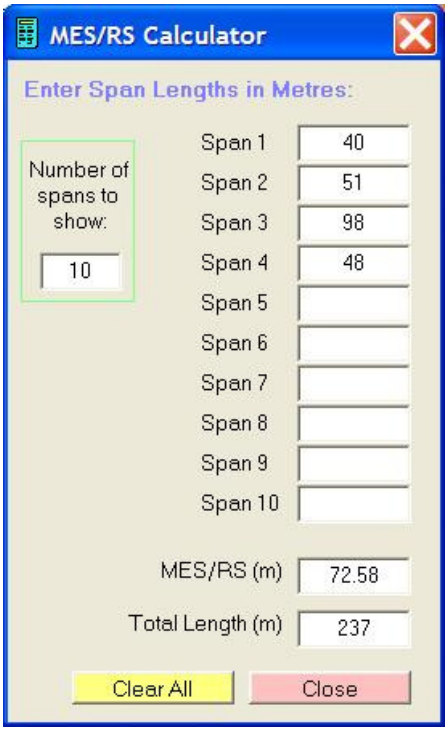
The conductor grid will display all conductors within the database that match your search criteria. Click on the line for the desired conductor.

Click on the Conductor Library icon if you find it necessary to add or edit the available conductors.

6.2 Span Length and MES/RS

Enter the span length. In the majority of cases this will simply be the horizontal distance between the two supporting poles. However, for lines on very steep terrain, you can also enter a vertical distance between the two supports as well, to obtain an effective length along the incline between the two support points. The left structure should be taken as the reference height, so that a positive value of vertical height is entered when the right hand support is higher than the left.

The MES/RS (mean equivalent span, or ruling span) will default to the span length entered. If the span is part of a strain section of mains where the spans differ significantly in length, and where the conductors are free to move at the intermediate supports (eg where a conductor is being strung on rollers), then it is recommended that MES/RS be entered, if known.



If MES/RS is not known, it can be calculated by clicking the *Calc* button next to the MES/RS field, and entering all span lengths within the strain section, ie between the strain/shackle points. The MES/RS will automatically calculate as span data is entered. Click on *Return/Exit* to return to the main Sag Tension Temperature module.

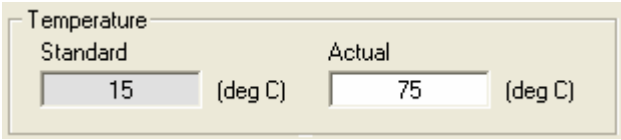
The MES/RS calculator form can be resized according to the maximum number of spans likely to be encountered within a strain section.

Note that if the *Span Reduction Factor* is checked in the *Options* settings (refer section 4.2), the Conductor Wind Pressure field will vary as the span length is modified.

> [The Mean Equivalent Span (MES) or Ruling Span(RS) is a theoretical 'average' span length that approximates the behaviour of spans within a strain section. Larger spans tend to dominate in the calculation. MES/RS becomes important in strain sections comprising varying span lengths when determining sag at other than the standard temperature.]

6.3 Temperature

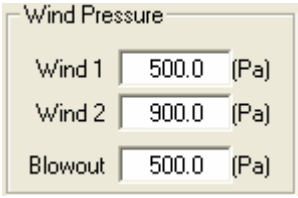
The standard temperature should already be set, according to the default value in the *Options* (refer section 4.4).



Enter the actual conductor temperature for this analysis below the standard temperature. This may be an actual temperature at the time sag was measured, or a design temperature for the line, eg the max. design temperature used to determine the worst case sag.

Note that conductor temperature may be slightly higher than the ambient temperature, due to the incidence of solar radiation (sunshine) on the conductor and I^2R heating by the load current. Of course, this heating is offset by the cooling effect of any breeze acting upon the conductor.

6.4 Wind Pressures



<u>Base Design Wind (1 & 2)</u> <u>Pressures</u> correspond to the practical worst-case wind pressures likely to be exerted upon the conductors. This will depend upon:

- weather patterns for the area
- the terrain and any shielding
- the direction of the wind
- the drag coefficient of the conductor – affected by its size and the roughness of its surface.

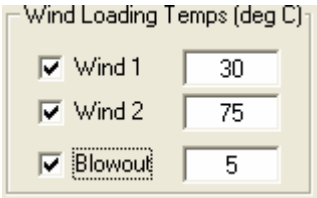
Values in the range of 500 – 1900 Pa are typical.

Blowout Calculation Wind Pressure is the wind pressure to be used for conductor blowout (horizontal sag) calculations. This is generally of the same order as the Base Design Wind Pressure or slightly less – typically in the range 500 – 1000 Pa.

Wind 1, Wind 2 and Blowout Pressures are loaded from *Options* (refer section 4.2) and can be overwritten in the module.

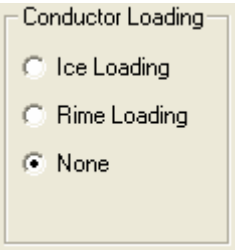
6.5 Wind Loading Temperatures

Wind Loading Temperatures allow for different temperatures to be used in the calculation of *wind loads* (i.e. Wind 1 @ 30º, Wind 2 @ 75º Blowout @ 5 º). To use this feature the relevant checkboxes must be checked and temperatures entered. The values entered are used instead of the *actual temperature* in tension calculations.



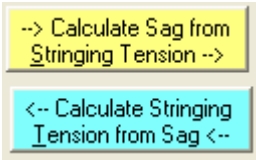
Wind 1, Wind 2 and Blowout Loading Temperatures are loaded from *Options* (refer section 4.2) and can be overwritten in the module.

6.6 Conductor Loading



The conductor may have additional weight added due to Ice or Rime loading depending on the location. The thickness of both Ice and Rime can be set in Options (refer section 4.3). If the conductor is not in an area affected by these phenomena then 'none' can be selected.

6.7 Calculate Buttons



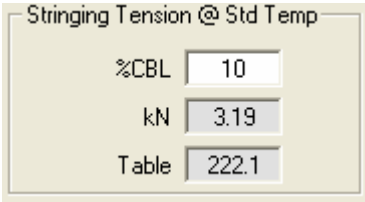
The module can perform two types of calculation:

(i) Calculate Sag for a known Stringing Tension, or

(ii) Calculate Standard Tension (at standard temperature) for a known Sag.

Enter either Standard Tension or Sag, and then click on the appropriate button.

6.8 Standard Tension



Standard tension is the nominal tension at which the line is installed, assuming that the conductor is at standard temperature. There are three options for entering standard tension:

(i) a percentage of CBL (calculated conductor breaking load, or ultimate tensile strength [UTS]) – values in the range 3% (slack) to 28% (very tight) are typical, depending upon the material and the distances to be spanned.

(ii) an actual tension value, expressed in kilonewtons (kN)

(iii) a stringing table. Some power authorities have a set of stringing tables that correspond to different tensions. The default stringing table provided with the program is one that gives the corresponding sag, in centimetres, in a 100m span of mains at standard temperature.

Click on the field corresponding to your preferred mode, then enter the value.

6.9 Sag

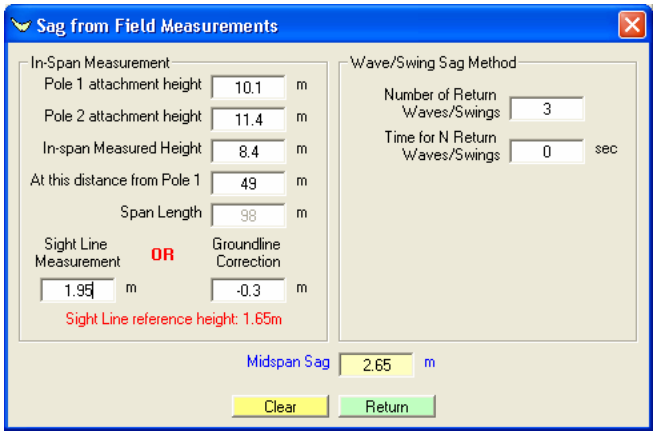
You have the choice of entering sag as:

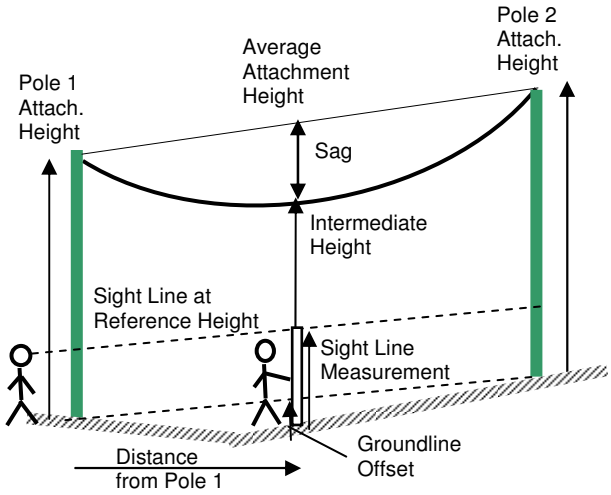
(i) a definite value, in metres, or

(ii) a percentage of span length. (Some authorities string cables according to a percentage-of-span rule.)

Click on the field corresponding to your preferred mode, then enter the value.

Should you need to calculate sag from conductor height measurements, click on the 'Sag' button. This will activate the screen shown below. Enter the conductor heights at either end of the span and at an intermediate point within the span (the midpoint by default). If there is a dip or hump mid-span which affects the accuracy of the mid-span measurement, you may enter a groundline correction value (either positive or negative), or a sight-line measurement.





The sag calculator also allows times from wave or swing sagging to be entered. Under the wave sagging method, the conductor is struck or 'plucked' at one end, creating a travelling wave which propagates along the conductor, reflects back from the other end of the span and back again until it dies out. Similarly, the swing method of sagging involves pulling the conductor to one side at its midpoint, and allowing it to swing like a pendulum. There is a mathematical relationship between the period and the sag. Typically 3 returns or full swings are timed using a stopwatch. This method is accurate but not very precise and any errors in timing can significantly affect the outcome.

Once the sag has been calculated, click the 'OK' button which will return this value to the Sag Tension Module and click on 'Calculate Stringing Tension from Sag'.

6.10 Results

The program will calculate either the sag or the stringing tension. It will also calculate the following elements:

Actual tension (horizontal) in the conductor is calculated for 'No Wind', 'Wind 1' and 'Wind 2' conditions. It is expressed as a value in kilonewtons (kN), or as a percentage of CBL. As a general rule, conductors should be strung such that they do not exceed 50% CBL under worst-case conditions.
Generally, the 'Wind 1' and 'Wind 2' (short duration or ultimate strength limit) conditions are the critical ones in determining the integrity of the structure. However, for tightly strung conductors on wood poles, the 'No Wind' (sustained or serviceability limit) state may be the limiting condition.

Actual Tension - Horizontal

	kN	%CBL
No Wind	1.67	5.24
Wind 1	4.42	13.87
Wind 2	4.89	15.32

~~The program makes allowance for conductor stretch under wind conditions.~~

Actual tension (vertical download) in the conductor is calculated for 'No Wind', 'Wind 1' and 'Wind 2' conditions. Values are calculated for the structures at either end of the span.

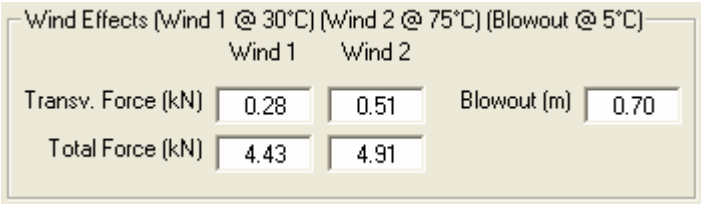
Actual Tension - Vertical Download

	Left Struct. (kN)	Right Struct. (kN)
No Wind	0.17	0.17
Wind 1	0.17	0.17
Wind 2	0.17	0.17

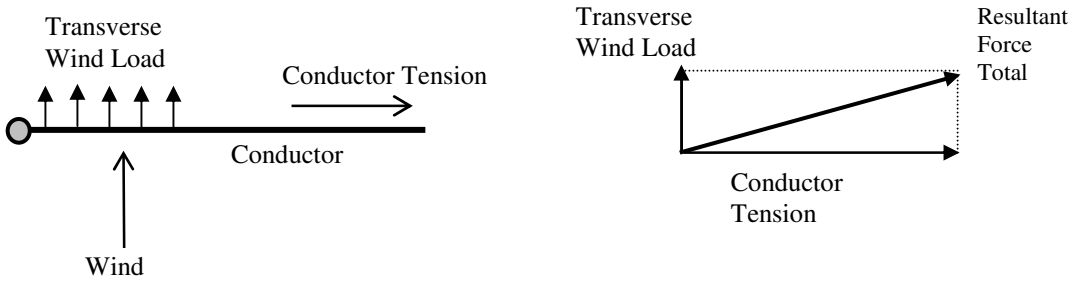
The left structure attachment point is assumed to be at datum with the right structure attachment point offset vertically by the value entered for *Vertical*.

Negative values denote an upward force applied on the structure by the conductors (ie potential uplift).

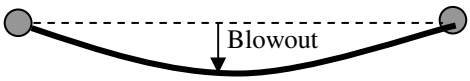
Transverse wind loads on each half-span of mains for 'Wind 1' and 'Wind 2', in kN, which is generally small in comparison with the longitudinal (axial) force in line with the conductor.



Total force exerted by the conductor on the support structure for 'Wind 1' and 'Wind 2', the vector sum of the axial tension in the line of the conductor and the transverse wind load, as shown below.



Blowout is the horizontal 'sag' or bowing of the conductor at midspan under the nominated blowout wind condition, ie the distance the conductor is pushed to the side by the wind. This value is useful for checking proximity of the conductors to embankments or nearby structures. It is also useful for determining easement widths. Most electricity authorities specify a standard temperature at which blowout should be calculated, eg 30°C.



Note that the user may alter the default values from the Options Settings for conductor design wind pressure and blowout wind pressure as well as the wind loading temperatures.

6.11 Printing a Report

Click on the printer icon to print a report.

6.12 Saving a Study

Click on the disk icon to save a sag/tension/temperature study. Enter a project/study name, file name (defaults to project/study name, plus extension *.pnw*). You may nominate the folder in which the file is stored.

All 'Conductor' and 'Material' data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that the calculations will give the same results anywhere the study is opened.

6.13 Clearing the Screen

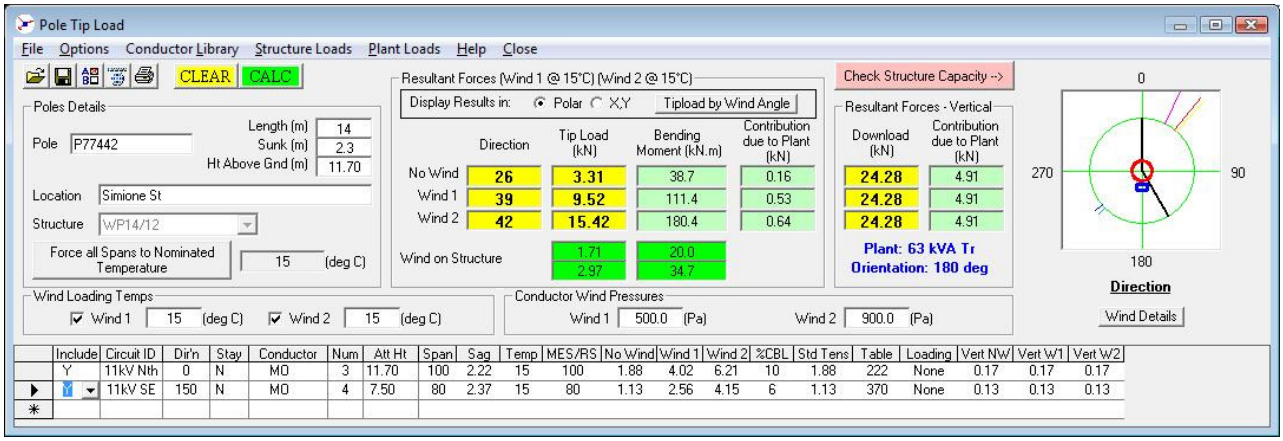
Click on *Clear* to remove all details of the conductor.

6.14 Opening a Study File

Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

If Conductor/Material data in the saved file is different to that on the host machine, then the user will be shown the two sets of parameters and will be asked which set that they wish to adopt for that profile. Changes are temporary and will be lost upon exiting of the program.

7. TIP LOAD MODULE



7.1 Overview of Module and Main Form

The user enters:

- information about the pole/structure (upper left corner of form), or via the *Structure Loads* menu option
- any temperature or wind pressure values different from the default settings (above the data grid, central to the form)
- information concerning any pole-mounted plant, if applicable, via the *Plant Loads* menu option
- details of the conductor spans attached to the pole, as well as any stay, if applicable (grid at base of form).

Clicking the *CALC* button causes results to be displayed in the upper right and centre of the form. The plan view at the top right of the form shows the pole, circuits (conductors), stays and plant according to their direction.

Clicking the *Check Structure Capacity* then allows the loads to be compared with the structure capacity or wood pole strength.

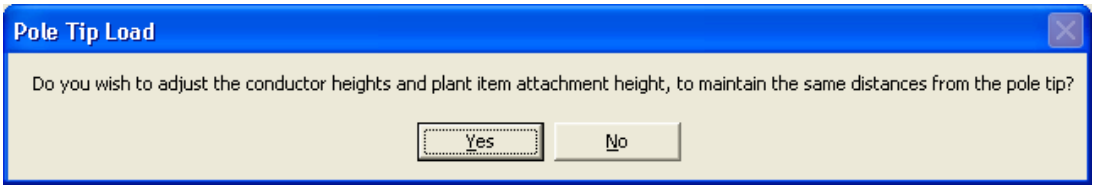
7.2 Pole ID and Project/Location

Entry of the Pole ID number and Project Location/Description/Address is useful when the study is to be printed or saved.

7.3 Pole Dimensions and Tip Height

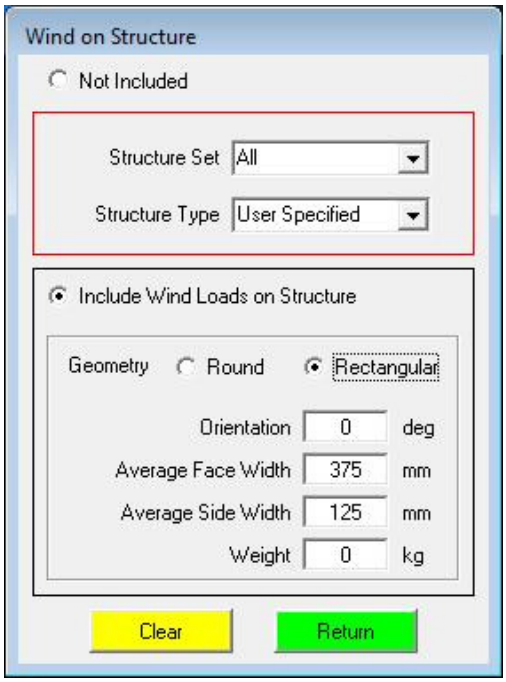
Pole height is calculated automatically from pole length by deducting the sinking depth. A default sinking depth is calculated using the parameters in the *Options* settings (refer section 4). This value may be modified within the *Tip Load* module. Alternatively, the user may simply enter the pole height above ground or, if *Structures* are entered (refer section 14), the user may select the structure from the *Structures* list, which will fill in the *Length*, *Sunk* and *Ht Above Gnd* fields accordingly.

If the pole's *Ht Above Gnd* is changed at any time, the program will ask if the conductor attachment heights and plant item attachment height should be updated appropriately. If *Yes*, then all conductor heights are updated as well as any plant item, otherwise they are left at their previous heights.



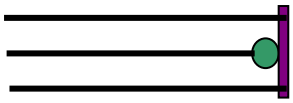
The plan diagram shows the pole as either round or rectangular in section, according to the *Options* settings or structure type entered.

By nominating a structure using the *Structure Loads* command, the user may also specify diameter or width of the pole.

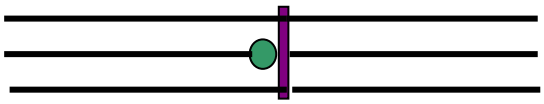


7.4 Entering a Circuit

A circuit is a group of electrically-related wires approaching a pole from a certain direction. A termination pole has one circuit attached; an intermediate pole has two, although the wires may physically continue through from one side to the other.



1 Circuit

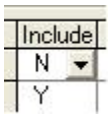


2 Circuits

Many authorities ignore minor service cables and telephony cables in their pole tip analyses.

To enter a circuit, start entering data for the circuit in the grid – generally in the column *Dir'n* (Bearing or Angle) or *Circuit ID*. After entering full or partial details of the circuit, hit the down arrow key or click on the next line of the grid to enter the next circuit. This will also cause the plan diagram showing circuits on the pole to be updated.

Note that **only the first 7 columns can have data entered directly by the user**. The remaining columns are derived from the entry made in the *Conductor* column and are used for display only.



The ***Include*** column need not be entered initially—it defaults to 'Y'. It may be toggled to 'N' where the user wishes to 'turn off' a particular circuit. This is a toggle that displays or hides the circuits not included in the calculation, in the grid and in any printouts. This feature is mainly used when the Tip Load module is invoked from the *Profiler* module. Right click on the grid and choose *Show Include=N Circuits* to toggle the viewing of these circuits in the grid.

The ***Circuit ID*** column is optional. It provides a way of naming circuits to keep track of which is which. You may enter a description such as "HV – North".

The ***Dir'n*** (Bearing or Angle) column is the circuit direction. You may wish to take an arbitrary direction as 0°, say the circuit on the approach side of the pole. Alternatively you may wish to enter compass bearings as the circuit directions.

In the ***Num*** column, enter the number of conductors in the circuit. For bundled cables, service cables, telecommunications cables, enter '1' even though there may be multiple insulated wires within the bundle. The default value preloaded into the form is held in *Options* (refer section 4).

Clicking in or navigating to the ***Conductor*** column activates the Sag-Tension-Temperature module. From within this module, nominate the conductor type, span length, MES/RS, temperature and stringing tension or sag. After calculating actual tensions, exit the *Sag-Tension-Temperature* module. The circuit details are updated automatically with the calculated loads.

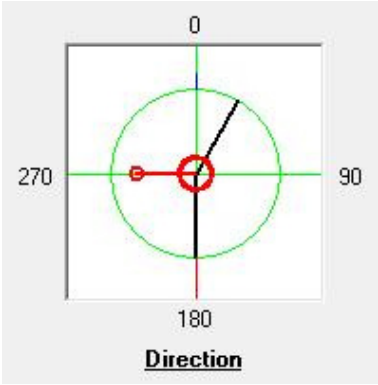
Tip Loads designates the studied pole as being what the *Sag Tension Temperature* module refers to as the left structure. Therefore, values adopted for the actual tension-vertical download are those of the left structure.

The program defaults the ***Attach Ht*** to the top of the pole. You may alter this if required, either by typing in an amended attachment height directly into the grid, or by clicking on the down arrow. This activates a window which enables the user to calculate the circuit height if the distance to the circuit from the top of the pole is known.

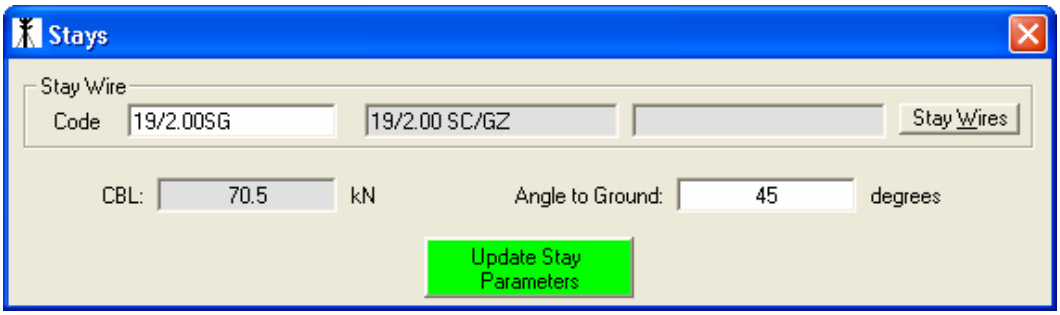
For non-flat constructions, where the conductors within the circuit attach to the pole at differing heights, take the average circuit height.

7.5 Entering a Stay

Enter the direction of the stay (ground stay or aerial stay), as for a circuit. In the ***Stay*** column, amend the value to 'Y'.



Optionally, click in the 'Conductor' column to activates the *Stay* form. Select the *Stay Wire* (in a similar manner to selecting Conductors). This will display the *CBL* of the stay wire and the stay's *Angle to Ground* (default is 45deg). Users may change the angle if required and then click on *Update Stay Parameters*.



It is assumed that the stay provides perfect passive resistance to the applied load on the pole, completely neutralising any component of the resultant load in its direction. Of course, if the stay is more than 90° away from the resultant load, then it will have no effect at all.

Once the *Calculate* button is pressed, the 'No Wind', 'Wind 1' and 'Wind 2' loads in the stay wire are displayed. These values are the loads that the stay will need to take to neutralise conductor and other forces. Decreasing the attachment height on the pole (which defaults to the pole tip height) will increase the stay loading. Similarly, increasing the stay wire angle to ground (which defaults to 45deg) increases the stay loading.

Include	Circuit ID	Dir'n	Stay	Conductor	Num	Att Ht	Span	Sag	Temp	MES/RS	No Wind	Wind 1	Wind 2	%CBL	Std Tens	Table	Loading	Vert NW	Vert W1	Vert W2
Y	HV west	0	N	MO	3	10.00	50	0.55	15	50	1.88	3.45	4.96	10	1.88	222	None	0.08	0.08	0.08
Y	HV east	150	N	MO	3	10.00	70	1.09	15	70	1.88	3.76	5.60	10	1.88	222	None	0.12	0.12	0.12
Y	LV west	0	N	LVABC95	1	8.00	50	1.56	15	50	2.66	4.60	7.15	5	2.66	622.1	None	0.33	0.33	0.33
Y		180	Y	19/2.00SG	45	10.00	0	0.00	0	0	4.08	15.81	20.74	0	0		None	2.88	11.18	14.66

7.6 Deleting a Circuit or Stay

To delete a circuit or stay, highlight the line of the circuit within the grid by clicking on the grey button to the left of the *Circuit ID* column. Use the *Delete* key on your keyboard to remove the selected circuit.

7.7 Conductor Wind Pressures and Wind Loading Temperatures

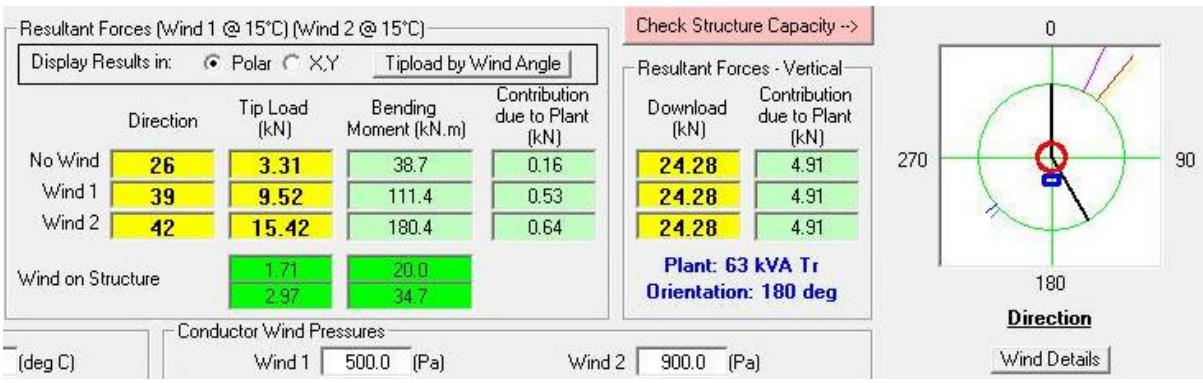
Wind 1 and Wind 2 Pressures are loaded from *Options* (refer section 4) and can be overwritten here if necessary.

Conductor Wind Pressures
Wind 1 500 (Pa) Wind 2 900 (Pa)

When the *Wind Loading Temps*. boxes are checked, this forces the wind loads to be calculated at the nominated temperatures entered rather than the actual temperature value used in the *Sag Tension Temperature* module. Default temperatures for wind loading are taken from the Options settings (refer section 4), but can be overwritten herein.

Wind Loading Temps
☐ Wind 1 15 (deg C) ☐ Wind 2 15 (deg C)

7.8 Results Display

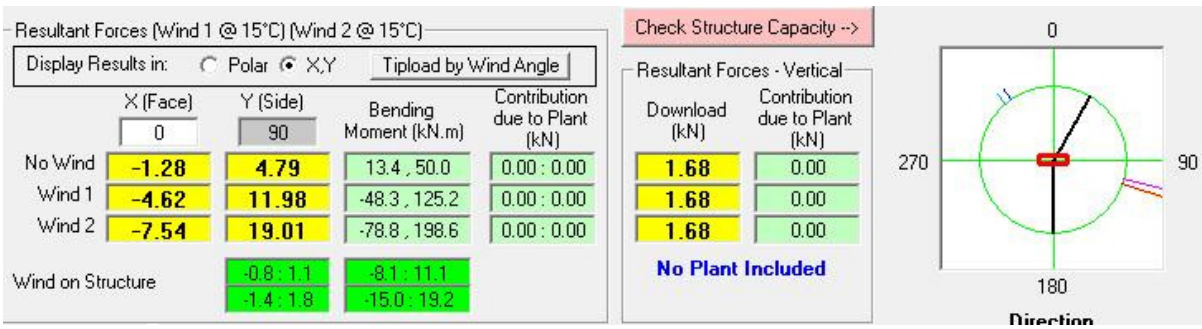


Clicking on the *CALC* button causes the resultant tip load to be calculated for 'No Wind', 'Wind 1' and 'Wind 2' conditions. The screen displays both equivalent tip loads (in kN) and bending moments (in kN.m). The latter is the product of tip load and pole height above ground. The self-windage of the pole/structure is also displayed if this option is selected in *Options* (refer section 4).

When in *Polar* mode, the direction of the resultant load is shown as well as the magnitude. The plan diagram shows the 'No Wind' condition resultant direction in magenta, 'Wind 1' condition resultant direction in red and 'Wind 2' condition resultant direction in yellow. The worst-case wind direction is shown as a blue tick mark on the green circle.

The resultant forces in the vertical direction on the pole are also displayed for the 'No Wind', 'Wind 1' and 'Wind 2' conditions (negative values denote potential uplift). Plant load components are shown where applicable.

When in *X,Y* mode, the worst case loads in the nominated X and Y directions are shown. This is useful for rectangular poles and checking that loads do not exceed capacity in either direction, although the *Polar* mode is best for determining ideal orientation for stays (opposite the resultant load direction). The X and Y loads are not merely the worst case polar values resolved to X and Y directions, but the worst case loads in each direction. The X direction (face) defaults to 0º and the Y direction (side) to 90º, but these may be altered by the user. For bending moment, structure wind load and contribution due to plant, the X and Y loads are shown separated by commas or colons.

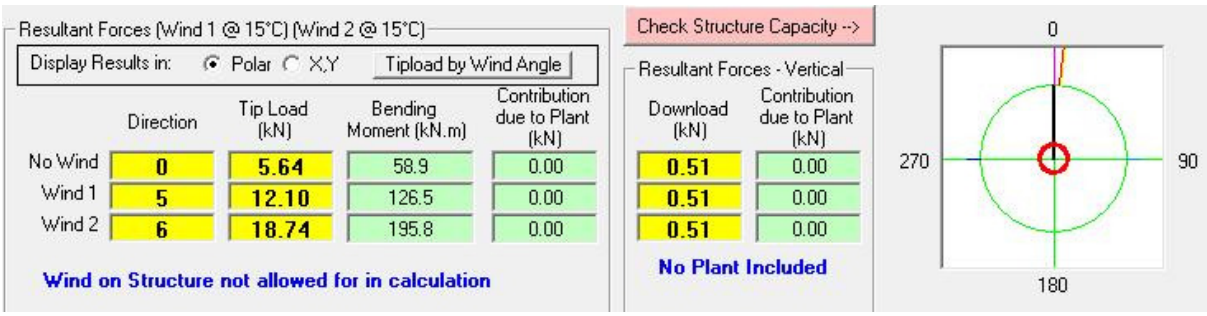


7.9 Interpreting Results

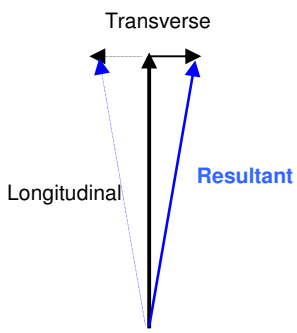
Note that *Poles 'n' Wires* applies wind from a range of directions between 0º and 360º, in steps of the size nominated in *Options*. The worst case results are noted, and displayed. In some cases there will be more than one worst case direction.

Note that the direction for 'Wind 1' and 'Wind 2' conditions may differ a little from that for the 'No Wind' condition. Also, **it is possible for there to be more than one worst-case wind direction**, although only one direction will be displayed. As a general rule, it is recommended that stays be positioned opposite the 'No Wind' resultant direction, although designers may need to use some judgment in this regard.

Some users may experience some confusion initially until it is understood how the program operates. The diagram below shows a single circuit in a direction of 0º. The No Wind load is in a direction of 0º, while the Wind1 load is in a direction of 5º. Note that a tick mark appears at 270º, indicating that this is a worst case wind direction.

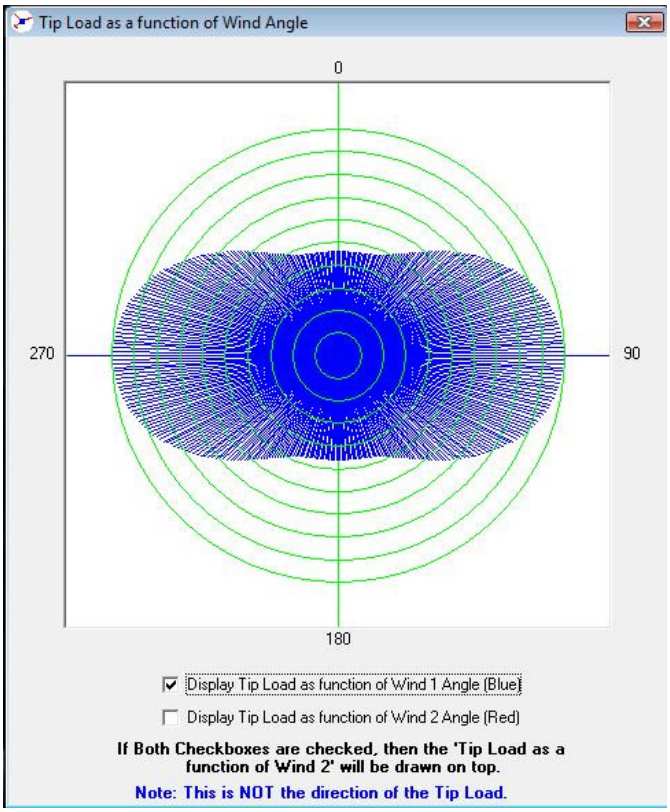


When the wind blows in a direction normal to the conductor, either from 90º or 270º, the conductor tension is at a maximum. The resultant tip load is the vector sum of the longitudinal load applied by the conductor and the small transverse wind loading on the conductor, acting at right angles to it. The vector summing of the longitudinal and transverse components accounts for the 5º orientation of the resultant. Of course, the Wind1 direction could equally have been taken to be 355º.



Note that the result is 6º for the Wind2 condition, where the wind pressure is higher. If wind force on the pole itself were also included, this would have further increased the transverse load and the angle of the resultant.

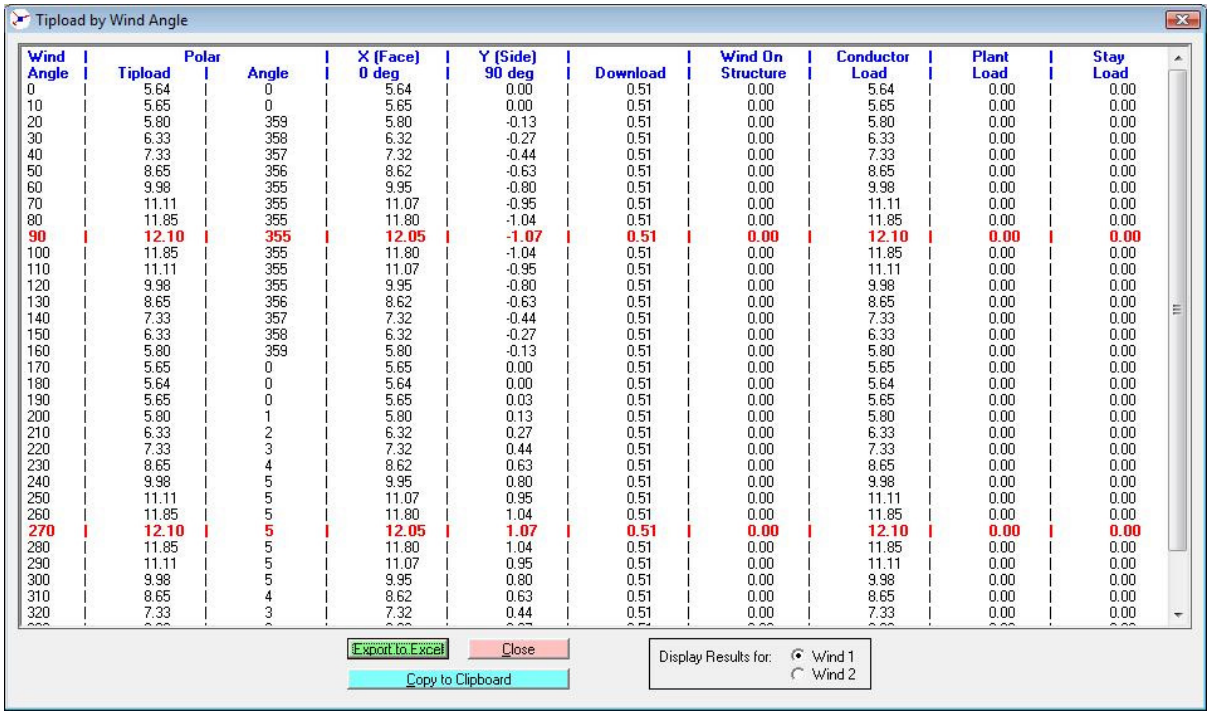
Clicking on the *Wind Details* button below the polar diagram (or the menu option) shows tip load as a function of wind direction, clearly showing the two worst case directions of 90º or 270º.



The *Tip Load by Wind Angle* button may also be used to show the tip load for each wind direction angle. Note how the 90º and 270º lines are highlighted in red.

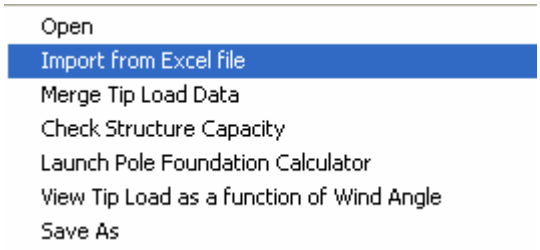
When in *X,Y* mode, the worst case wind directions for loading in the X direction and loading in the Y direction will be displayed in bold text.

If the program seems to be running slowly, use larger increments of wind direction, as set in *Options*. Where there is adequate computing speed or where precision is needed, 1º steps may be used.



Wind Angle	Polar Tipload	Polar Angle	X (Face) 0 deg	Y (Side) 90 deg	Download	Wind On Structure	Conductor Load	Plant Load	Stay Load
0	5.64	0	5.64	0.00	0.51	0.00	5.64	0.00	0.00
10	5.65	0	5.65	0.00	0.51	0.00	5.65	0.00	0.00
20	5.80	359	5.80	-0.13	0.51	0.00	5.80	0.00	0.00
30	6.33	358	6.32	-0.27	0.51	0.00	6.33	0.00	0.00
40	7.33	357	7.32	-0.44	0.51	0.00	7.33	0.00	0.00
50	8.65	356	8.62	-0.63	0.51	0.00	8.65	0.00	0.00
60	9.98	355	9.95	-0.80	0.51	0.00	9.98	0.00	0.00
70	11.11	355	11.07	-0.95	0.51	0.00	11.11	0.00	0.00
80	11.85	355	11.80	-1.04	0.51	0.00	11.85	0.00	0.00
90	**12.10**	**355**	**12.05**	**-1.07**	**0.51**	**0.00**	**12.10**	**0.00**	**0.00**
100	11.85	355	11.80	-1.04	0.51	0.00	11.85	0.00	0.00
110	11.11	355	11.07	-0.95	0.51	0.00	11.11	0.00	0.00
120	9.98	355	9.95	-0.80	0.51	0.00	9.98	0.00	0.00
130	8.65	356	8.62	-0.63	0.51	0.00	8.65	0.00	0.00
140	7.33	357	7.32	-0.44	0.51	0.00	7.33	0.00	0.00
150	6.33	358	6.32	-0.27	0.51	0.00	6.33	0.00	0.00
160	5.80	359	5.80	-0.13	0.51	0.00	5.80	0.00	0.00
170	5.65	0	5.65	0.00	0.51	0.00	5.65	0.00	0.00
180	5.64	0	5.64	0.00	0.51	0.00	5.64	0.00	0.00
190	5.65	0	5.65	0.03	0.51	0.00	5.65	0.00	0.00
200	5.80	1	5.80	0.13	0.51	0.00	5.80	0.00	0.00
210	6.33	2	6.32	0.27	0.51	0.00	6.33	0.00	0.00
220	7.33	3	7.32	0.44	0.51	0.00	7.33	0.00	0.00
230	8.65	4	8.62	0.63	0.51	0.00	8.65	0.00	0.00
240	9.98	5	9.95	0.80	0.51	0.00	9.98	0.00	0.00
250	11.11	5	11.07	0.95	0.51	0.00	11.11	0.00	0.00
260	11.85	5	11.80	1.04	0.51	0.00	11.85	0.00	0.00
270	**12.10**	**5**	**12.05**	**1.07**	**0.51**	**0.00**	**12.10**	**0.00**	**0.00**
280	11.85	5	11.80	1.04	0.51	0.00	11.85	0.00	0.00
290	11.11	5	11.07	0.95	0.51	0.00	11.11	0.00	0.00
300	9.98	5	9.95	0.80	0.51	0.00	9.98	0.00	0.00
310	8.65	4	8.62	0.63	0.51	0.00	8.65	0.00	0.00
320	7.33	3	7.32	0.44	0.51	0.00	7.33	0.00	0.00

7.10 Importing Tip Load Data



Under the File menu is *Import from Excel* file which allows for the entry of tip load data directly from an *Excel* spreadsheet. It is advised that the user enters the pole details (Length, Sinking Depth) or selects a Structure before launching this feature so that the Attachment Heights are brought in accurately.

The *Excel* file should be in the following format:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Circuit ID	Direction	Stay	Conductor	Num Conds/Stay Angle	Attach Ht	Span	MES	Temp	%CBL	Std Tens	Table	Sag	H1	H2	Hmid	dFromH1	GL offset
2	1	0	N	MO	3	9	10	10	15					5	5	3	5	0.5
3	2	90	N	MO	3	8	20	20	15			220						
4	3	180	N	MO	3	7	30	30	15				3					
5	4	225	N	MO	3	6	10	10	15		2							
6	5	270	N	MO	3	6	10	10	15	10								
7	6-Stay	27	Y															

The stringing tensions may be based upon one of the following, depending upon what column is entered:

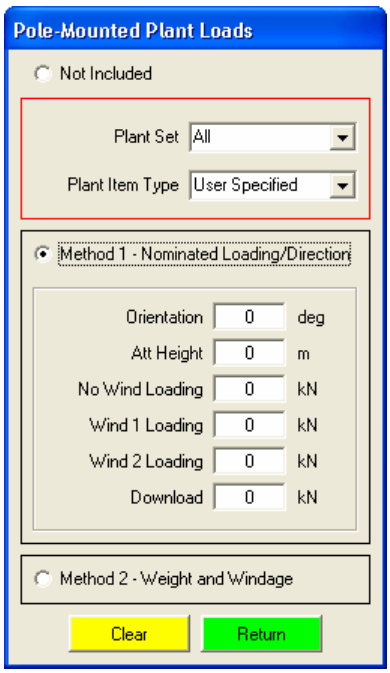
- %CBL
- standard tension
- stringing table, or
- sag
- the H1 (Height at Attachment Point 1), H2 (Height at Attachment Point 2), Hmid (Height at Mid Point), dFromH1 (Distance from Attachment Point 1) and GL offset (Groundline Offset at Mid Point), all of which are used to calculate sag.

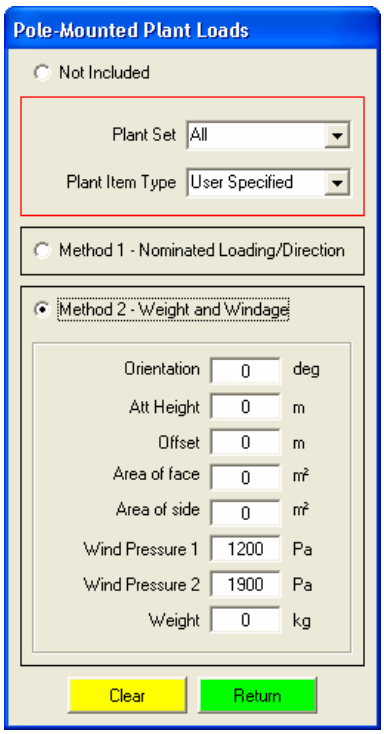
7.11 Plant Loads

Pole load due to Pole-Mounted Plant may be taken into account by clicking on the *Plant Loads* menu, which opens the *Pole-Mounted Plant Loads* form. Plant Items may be selected from the *Pole-Mounted Plant Database* (refer section 16) or manually specified.

Pole-Mounted Plant calculations may be performed using one of the following two methods:

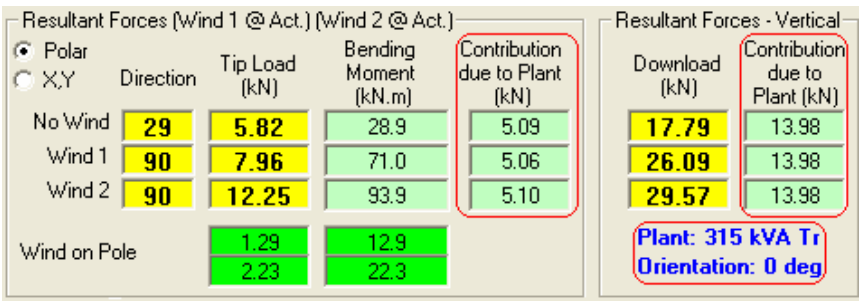
- Nominated Loading (Method 1) – where loadings due to the plant item are taken to be set values, and the user simply enters the orientation (direction) of the plant item and attachment height.
- Weight and Windage (Method 2) – where the weight, horizontal offset from pole axis, download and the area of the face and sides of the plant item are known. Wind pressures are applied to the plant item to calculate loadings. The user simply enters the orientation (direction) of the plant item and attachment height.



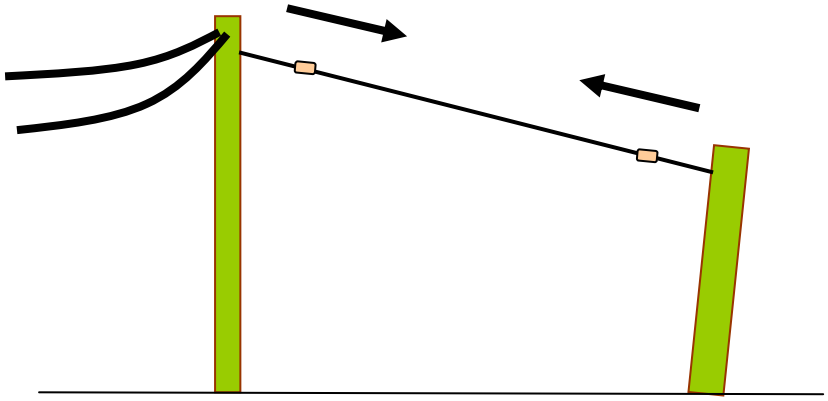


For method 1, the *Wind Pressures* are initially loaded from Options (refer section 4.1), but can be overwritten.

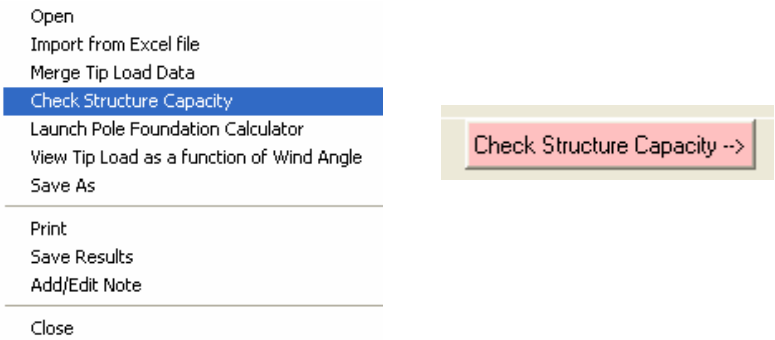
Once the plant details have been entered, click *Return* and the plant load will be added to all future tip load calculations. The plant item type, as well as, its *Orientation* is displayed below the *Resultant Forces – Vertical*. In addition to these loads being added to the tip load calculations, the *Contribution due to Plant* is displayed.



Tip: If you need to apply a nominated load in a certain direction to a pole and wish to specify the kilonewton forces under No Wind/Wind1/Wind2 conditions, the Plant Loads method 1 provides a convenient mechanism to do this. For example, it can be used to model forces referred from a line pole to a stay pole via an aerial stay wire. The aerial stay acts like a passive stay on the line pole, but for the stay pole it actively applies a force equal to the tip load generated by the conductors on the line pole.



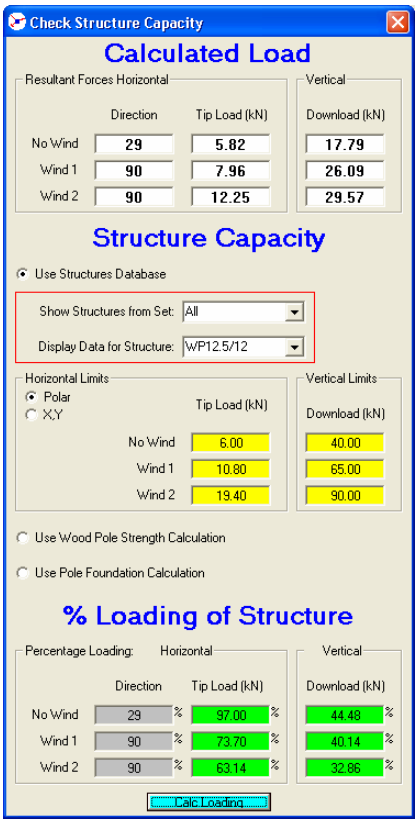
7.12 Check Structure Capacity

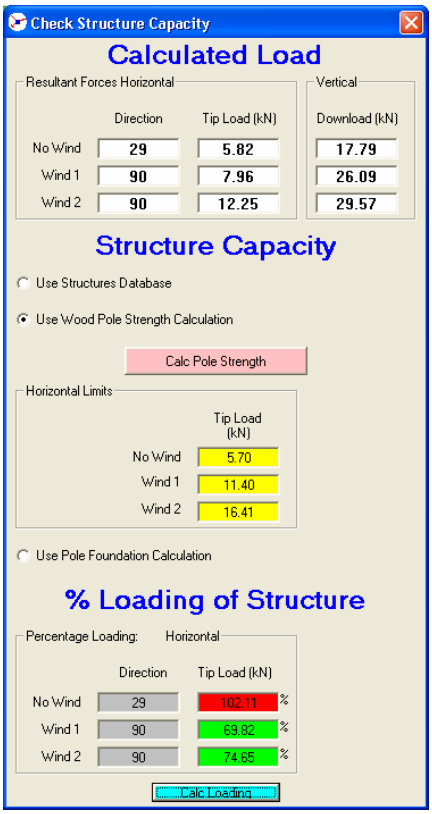


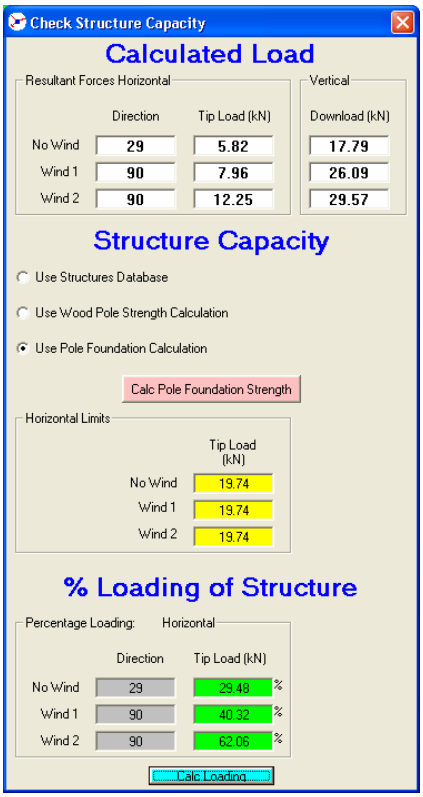
This facility is located in the File menu or from the *Check Structure Capacity* button. It maybe used to compare the calculated resultant tip load with either the structure capacity (from the Structures Database), or the strength calculated with the Wood Pole Strength module, or the strength of the foundation using the simple Foundation Strength module.

If the pole is round in section, then make sure the Tip Loads module is set to *Polar* mode, but if rectangular, the *X,Y* mode should be selected.

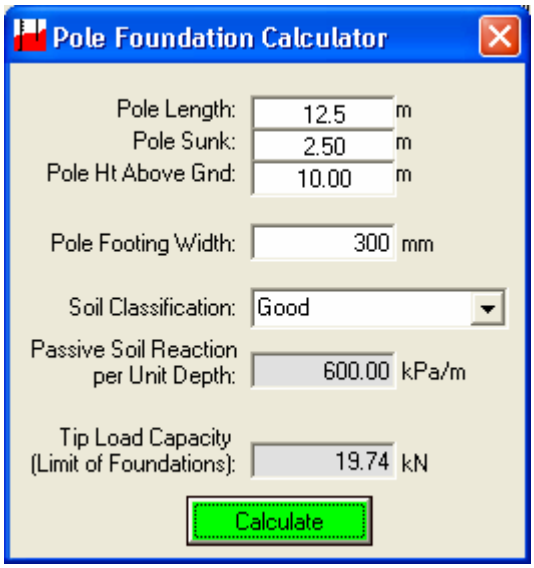
After all fields are selected/calculated, click on the *Calc Loading* button. This will calculate and display the percentage loading of entered data (empty fields will not be displayed).


Check Structure Capacity
Calculated Load
Resultant Forces Horizontal
Vertical
Direction
Tip Load (kN)
Download (kN)
No Wind 29 5.82 17.79
Wind 1 90 7.96 26.09
Wind 2 90 12.25 29.57
Structure Capacity
Use Structures Database
Show Structures from Set: All
Display Data for Structure: WP12.5/12
Horizontal Limits
Polar
X,Y
Tip Load (kN)
Vertical Limits
Download (kN)
No Wind 6.00 40.00
Wind 1 10.80 65.00
Wind 2 19.40 90.00
Use Wood Pole Strength Calculation
Use Pole Foundation Calculation
% Loading of Structure
Percentage Loading:
Horizontal
Vertical
Direction
Tip Load (kN)
Download (kN)
No Wind 29 % 97.00 % 44.48 %
Wind 1 90 % 73.70 % 40.14 %
Wind 2 90 % 63.14 % 32.86 %
Calc Loading


Check Structure Capacity
Calculated Load
Resultant Forces Horizontal
Vertical
Direction
Tip Load (kN)
Download (kN)
No Wind 29 5.82 17.79
Wind 1 90 7.96 26.09
Wind 2 90 12.25 29.57
Structure Capacity
Use Structures Database
Use Wood Pole Strength Calculation
Calc Pole Strength
Horizontal Limits
Tip Load (kN)
No Wind 5.70
Wind 1 11.40
Wind 2 16.41
Use Pole Foundation Calculation
% Loading of Structure
Percentage Loading:
Horizontal
Direction
Tip Load (kN)
No Wind 29 102.11 %
Wind 1 90 69.82 %
Wind 2 90 74.65 %
Calc Loading


Check Structure Capacity
Calculated Load
Resultant Forces Horizontal
Vertical
Direction
Tip Load (kN)
Download (kN)
No Wind 29 5.82 17.79
Wind 1 90 7.96 26.09
Wind 2 90 12.25 29.57
Structure Capacity
Use Structures Database
Use Wood Pole Strength Calculation
Use Pole Foundation Calculation
Calc Pole Foundation Strength
Horizontal Limits
Tip Load (kN)
No Wind 19.74
Wind 1 19.74
Wind 2 19.74
% Loading of Structure
Percentage Loading:
Horizontal
Direction
Tip Load (kN)
No Wind 29 29.48 %
Wind 1 90 40.32 %
Wind 2 90 62.06 %
Calc Loading

7.13 Simple Pole Foundation Calculator



This facility is located in the File menu and may be used to calculate the Tip Load capacity based upon the Foundations of the Pole. The Pole Length, Sunk and Height above Ground are transferred into the *Pole Foundation Calculator*.

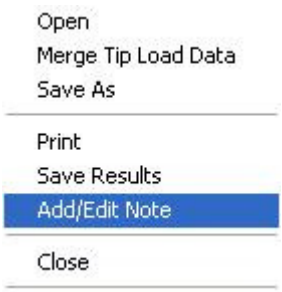
This is a very simple foundation calculator for bored piers in single layer soils, based upon the equations in ESAA HB C(b)1 1991 edition (more suited to working stress designs).

7.14 Force all Spans to Nominated Temperature

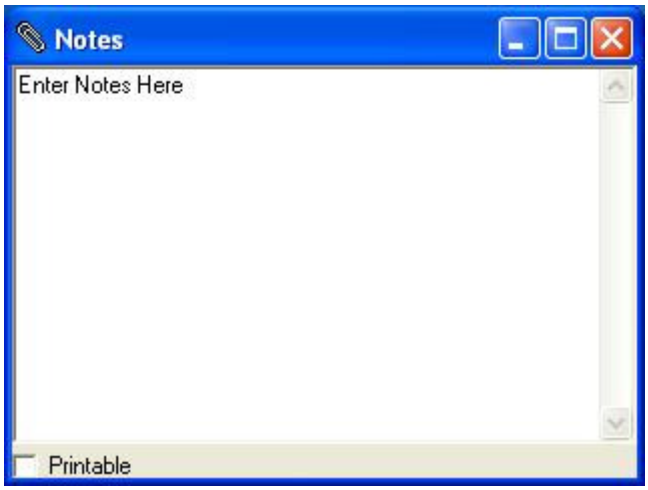
This facility may be used where conductor spans are modelled at various temperatures for other purposes, such as checking clearances or uplift. This is mainly used in the case where the Tip Load Module is invoked from the *Line Profile* Module (refer section 9). This allows the user to force all the listed spans temperatures to a single temperature value so that an accurate tip load can be calculated, typically the standard No Wind temperature.

7.15 Add/Edit Note

A note may also be added to the project file if desired. To add/edit, click on the File menu and choose *Add/Edit Note*.

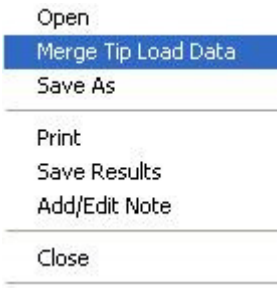


When printing, the user can select whether to print the note.



7.16 Merge Tip Load Data

This function adds two or more tip load calculations together. However, no error checking is done (for example, to confirm the data is about the same pole).



This function is useful to create a total tip load for a pole this is in two profiles, for example the pole is at crossroads, and there has been two profiles along the intersecting roads, and the *Pole Forces* function in *Profiler* has been has used to create the tip load files.

7.17 Printing a Report

Click on the printer icon to generate a printed report. It is recommended that you enter Pole ID and location prior to printing the report.

7.18 Saving a Study

It is recommended that you enter Pole ID and location prior to saving the study.

Click on the disk icon to save the study. The default file name is the Pole ID, and the extension is type *.pnw*. You may nominate the folder in which the file is saved.

All 'Conductor', 'Material', 'Pole Mounted Plant' data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that the calculations will give the same results anywhere the study is opened.

7.19 Clearing the Screen

Click on *Clear* to remove all details of the pole and attached circuits.

7.20 Opening a Study File

Click on the open folder icon to open a study. Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

If Conductor/Material/Pole Mounted Plant data in the save file is different to that on the host machine, then the user will be shown the two sets of data and will be asked which set of parameters they wish to adopt for that study. Changes are temporary and will be lost upon exiting of the program

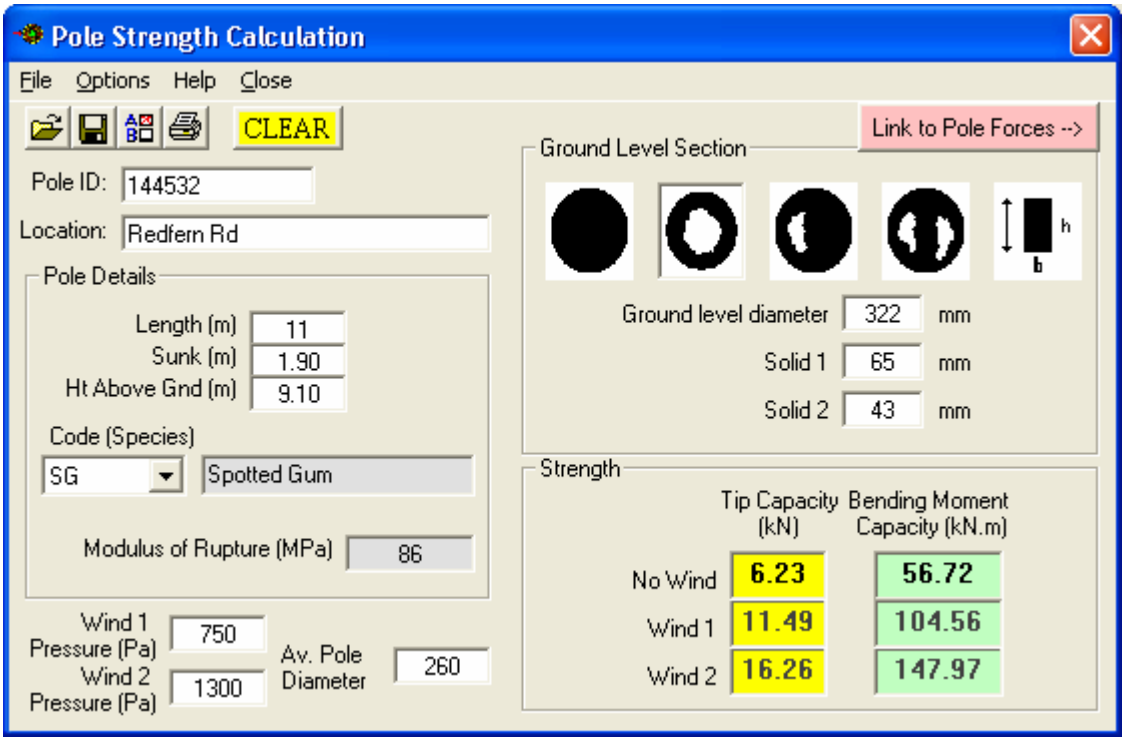
7.21 Grid Options

The column widths within the data grid where circuits and stays are entered may be adjusted by placing the cursor over the lines dividing the column headings, clicking and dragging. You may wish to resize the window to ensure all columns are visible.

If you right-click on the grid, a short menu will pop up with three options:

- *Clear Grid* clears all circuit data from the grid.
- *Restore Column Widths* resets the widths of all columns in the grid to default values.
- *Copy Selected Circuit* may be used to copy an existing circuit. This is a handy feature that saves a lot of data entry.

8. WOOD POLE STRENGTH MODULE



8.1 Application

This module is primarily for determining the strength of wood poles, ensuring that the applied bending moment does not exceed the strength of the outer fibres. It does not consider the 'column buckling' failure mode that can occur with thin-walled poles, the poles compressive capability or pole stability.

8.2 Pole ID and Project/Location

The pole identification number and location are not mandatory fields. Nonetheless, it is strongly recommended that these be completed prior to printing out or saving a study.

8.3 Pole Length, Sinking Depth and Height

After entering pole length, the program will calculate a nominal sinking depth, based upon the parameters in *Options* (refer section 4.3). Of course, you may enter the sinking depth directly. The height above ground will then be calculated by deducting the sinking depth from the length. If the height of the pole above ground is known, this also may be entered directly, without the user being concerned about length or sinking depth.

8.4 Material

Select the applicable pole material or timber species code. If uncertain of the code, enter the Options module – Pole Strength tab (refer section 4.3). You may then check through the available codes, or add new materials or timber species as required. (Refer section 4.5).

The strength of the material selected will be displayed (typically the modulus of rupture).

8.5 Ground Level Section

Select from the available shapes representing the ground-line section of the pole. These include:

- Solid Round. Enter ground line diameter in the resultant load direction.
- Hollow Round – this may be a pole that is manufactured with an internal hollow, or it may represent internal decay (hollows due to insects, timber shrinkage, rot or termite attack) in a timber pole. Enter external ground line diameter in the resultant load direction, as well as the depth of solid material on both the sides of the pole.
- Round with Single-sided Internal Decay. Enter the ground line diameter in the resultant load direction, the amount of solid material and the amount of internal decay.
- Round with Double-sided Internal Decay, or an annulus of decay, say between the heartwood and the sapwood. Enter the ground line diameter in the resultant load direction, the amount of solid material and the amount of internal decay.
- Rectangular or Square. Enter the breadth *b* (in the direction of the neutral axis) and depth *h* (in the direction of the resultant load) of the pole at ground line.

Note the following when taking ground line measurements:

- Any external decay should be deducted from the ground line measurement.
- Measure slightly below ground line, if necessary, where the pole is narrowest.

8.6 'Windage' Diameter

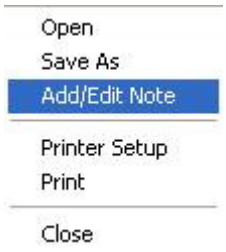
This is the width or diameter of the pole for the purposes of calculating wind forces on the pole itself.

Where the option has been selected to de-rate the pole tip capacity by an allowance for pole windage (refer *Options* section 4.1), then a default pole diameter will be shown, calculated as a percentage of pole length. You may alter the actual value of diameter/width if you wish, using simply the ground-line diameter, or the average value of the pole diameter midway up the pole, to be more precise in your calculation if the pole is tapered.

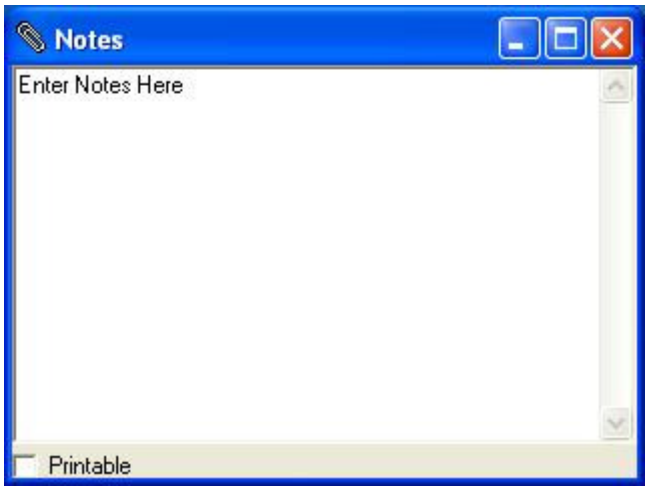
The 'Wind 1' and 'Wind 2' Pressure should be selected to make due allowance for drag, according to whether the pole is round or square in section and surface roughness.

8.7 Add/Edit Note

A note may also be added to the project file if desired. To add/edit, click on the File menu and choose *Add/Edit Note*.



When printing, the user can select whether to print the note.



8.8 Results

The pole tip capacity in kN, as well as bending moment capacity in kN.m, is displayed for both the 'No Wind' and 'Wind 1' conditions. If a 'MSF Wind 2' value is entered in the *Pole Strength Materials Database* on the *Pole Strength* tab of *Options* (refer section 4.5) then these values will also be displayed for the 'Wind 2' condition.

8.9 Printing a Report

It is recommended that you enter Pole ID and location prior to printing the report. Click on the printer icon to activate the report.

8.10 Saving a Study

It is recommended that you enter Pole ID and location prior to saving the study.

Clicking on the disk icon causes the file to be saved. The default file name is the Pole ID, and the extension is type *.pnw*. You may nominate the folder in which the file is to be saved.

All 'Pole' data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that all calculations will give the same results anywhere the study is opened.

8.11 Opening a Study File

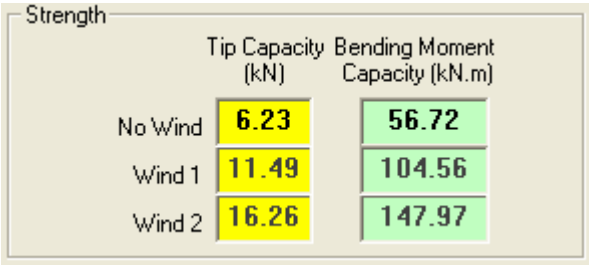
Click on the open folder icon to browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the required file to select it and then click the *Open* button.

If Pole data is different in the save file to that on the host machine, then the user will be shown the two sets of data and will be asked which set of parameters they wish to adopt for that study. Changes are temporary and will be lost upon exiting of the program

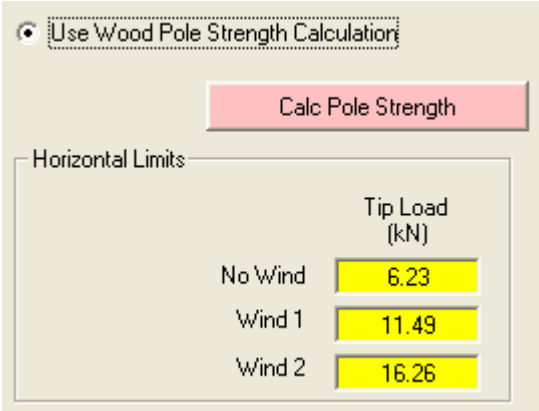
8.12 Link to Pole Tip Load Calculator

A link is provided to the Pole Tip Load Calculator so that pole strength can be compared with the applied tip load.

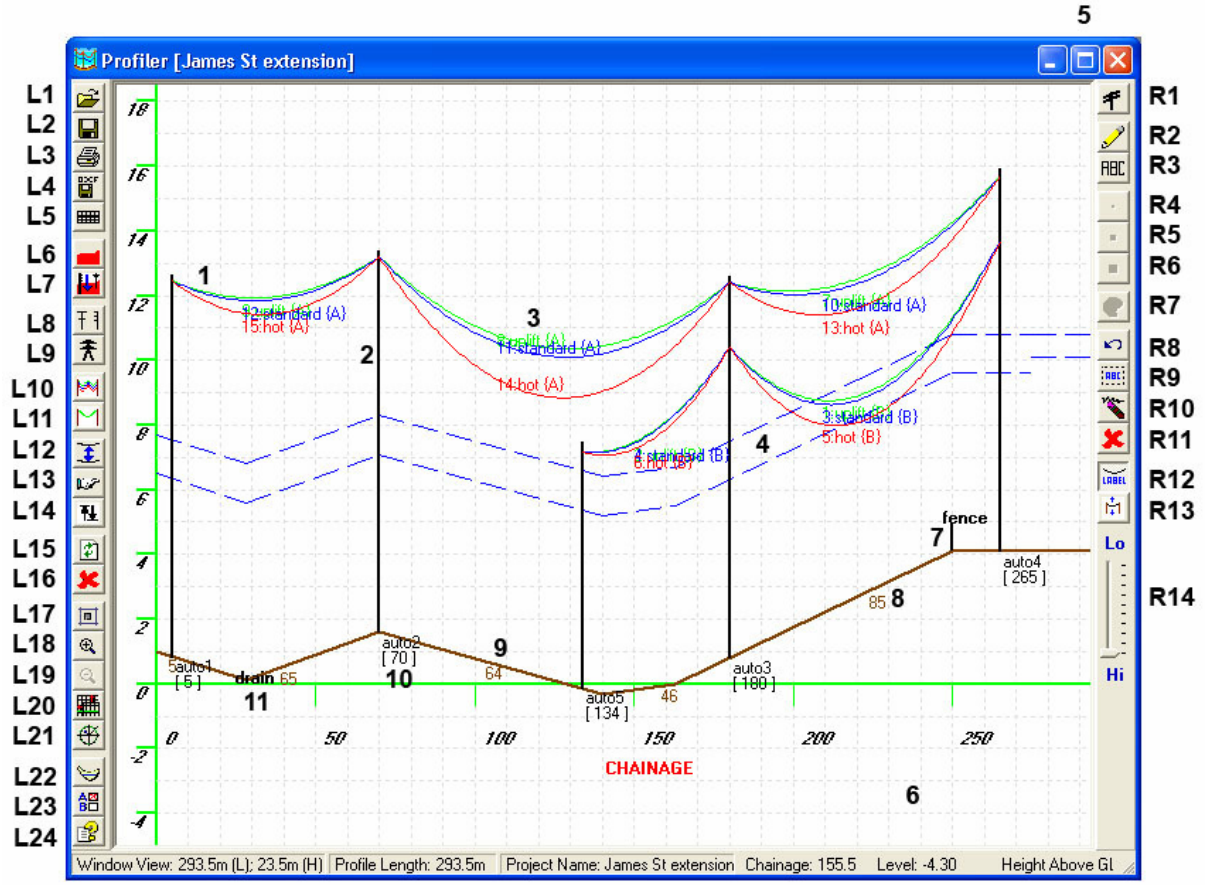
The pole ID, location and height are transferred from the strength module to the *tip load* module (refer section 7).



If *Check Structure Capacity* is then launched from the *tip load* module (refer section 7.13), then the calculated Pole Strength Tip Load Capacities from here are transferred across and *Use Wood Pole Strength Calculation* is selected.



9. LINE PROFILER MODULE



Legend

ID	Description	ID	Description	ID	Description
L1	Open File	**L18**	Zoom In	**R11**	Delete all Annotations
L2	Save File	**L19**	Zoom Out	**R12**	Display Circuit Labels
L3	Print	**L20**	View Bounds	**R13**	Change Sag
L4	Export Profile	**L21**	Planview	**R14**	Resolution Slider
L5	Create Schedules	**L22**	Sag Tension	**1**	Circuit (conductor/cable)
L6	Enter Groundline	**L23**	Options	**2**	Pole/Structure
L7	Import Groundline/Poles	**L24**	Help	**3**	Circuit Label
L8	Enter Poles	**R1**	Insert Pole	**4**	Clearance Lines
L9	Poles/Structures Database	**R2**	Draw Line	**5**	Maximise
L10	Enter Circuit Segments	**R3**	Text Annotation	**6**	Grid
L11	Enter Circuit Spans	**R4**	Line Width Narrow	**7**	Line Annotation
L12	Measure	**R5**	Line Width Medium	**8**	Span Lengths
L13	Move all to Right	**R6**	Line Width Heavy	**9**	Ground Line
L14	Change GL Start Level	**R7**	Set Colour	**10**	Pole ID and Chainage
L15	Refresh Screen	**R8**	Remove Last	**11**	Text Annotation
L16	Clear Screen	**R9**	View/Edit Annotations		
L17	Zoom Extents	**R10**	Delete Line		

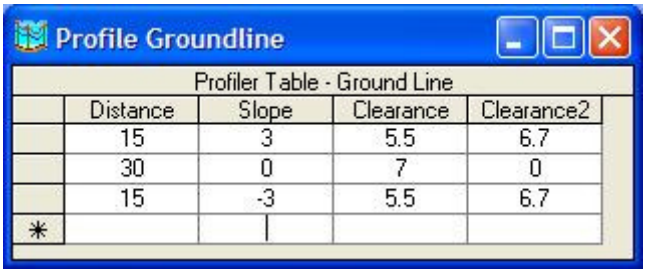
9.1 Entering the Ground Line

The starting point for any line profile is the ground line.

Poles 'n' wires defaults to flat ground for the length of the profile. To amend this, or to enter a ground clearance offset line, click on the *Ground Line* button.

If your *Options* (refer section 4.6) are set up for entry of distance and slope angle, then the data grid will allow you to enter details of segments of ground, each with constant slope, from left to right, using a grid such as the one shown below. Your options allow for entry of either distance following the slope or true horizontal distance. A positive slope rises from left to right; a negative slope falls away. Slopes must be in the range -90° to 90°.

The ground to the right will extend indefinitely as a flat line to the right of the last segment entered, at the same level as the final level of the segment.



	Distance	Slope	Clearance	Clearance2
	15	3	5.5	6.7
	30	0	7	0
	15	-3	5.5	6.7
*				

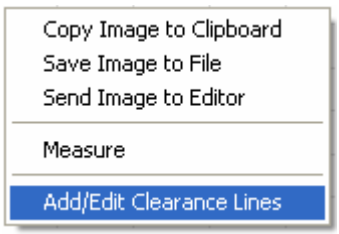
NOTE: Ground Line points in distance and slope angle **format must be entered in sequence.**

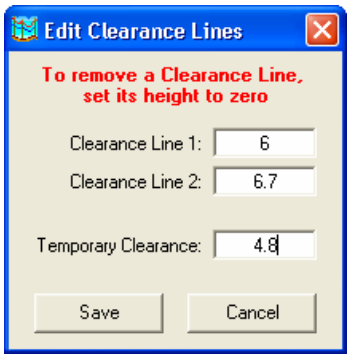
Alternatively, the *Options* may be set-up for plotting of points in terms of chainage (horizontal distance *x* relative to the start of the section) and level (vertical height *y* relative to the datum '0' line shown on the plot), as shown below. The first point entered should be for a chainage of 0. You may wish to make the height here 0, or any other convenient level (such as the RL supplied by a surveyor).

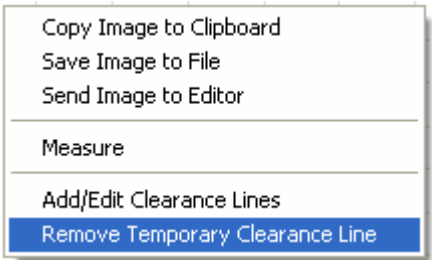
At least two points must be entered, to form a segment of ground. The ground to the right will extend indefinitely as a flat line to the right of the last point entered.

	Chainage	Level	Clearance	Clearance2
	0	0	6	6.7
	47	3.7	6	6.7
	89	4.12	6	6.7
	177	3.02	6	6.7
	199	2.05	6	6.7
	269	1.32	6	6.7
	370	2.86	6	6.7
	420	1.97	6	6.7
*				

For each point, you may nominate the required ground clearance for the lowest circuit. This is used to draw a blue dashed line offset by a fixed distance from the ground. Any circuit that crosses below this line is then under-height. *Poles 'n' Wires* allows two clearance lines to be entered (eg one indicating the required height for lines over roadways and one indicating the required height elsewhere, or one for high voltage and another for low voltage lines). If no entry is made in the data grid fields for clearance, the program will default to the values set in *Options (refer section 4.6)*. Also, by right-mouse clicking on the screen and choosing *Add/Edit Clearance Lines*, the user can change the default clearance lines and create, edit and remove an additional clearance line, as shown below.







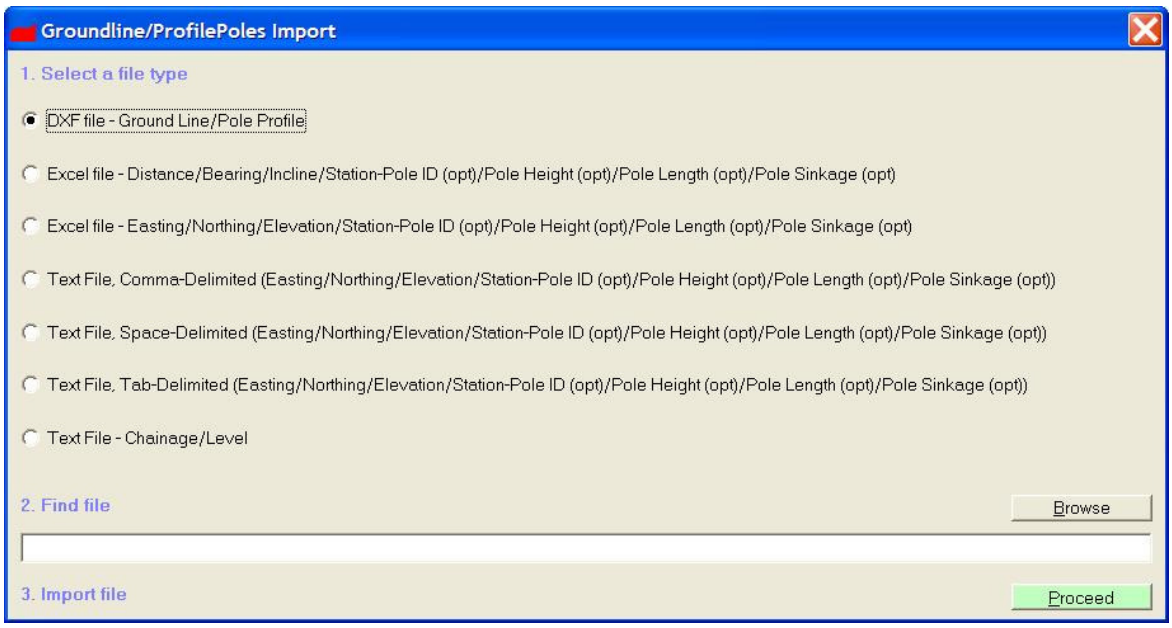
To remove a ground line segment or point, click on the square to the left of the relevant line in the data grid, highlighting the line, then press the *Delete* key on your keyboard.

When entering ground line points in chainage/level format, you may insert intermediate ground line points. To do this, add new points at the end of the list in the grid. Then place the mouse over the grid and click on the right mouse button. Then click on the *Sort by Chainage* line of the pop-up menu, as shown to the left.

When entering ground line points in distance/slope format, you may insert points by clicking on the right mouse button with the mouse over the grid, as shown below. This allows new points to be inserted before or after the active point line.

This section has been updated by section 20 at the end of this manual

9.2 Importing Ground Line/Profile Pole Data



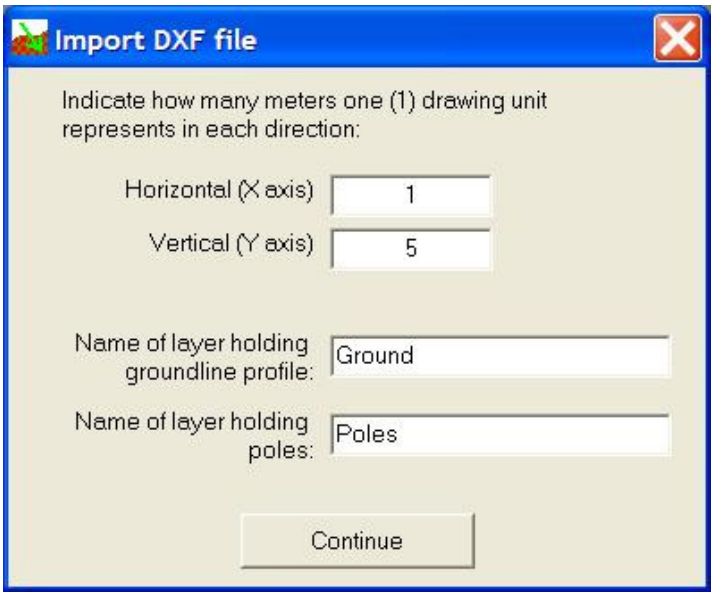
Rather than enter ground line points and pole data directly into the *Profiler*, you may import ground line and pole data from an external file, using the appropriate button on the toolbar. This may be useful for longer profiles or when data is drawn from a survey. The data may be imported in several file formats, as shown above.

Note that it may be necessary to click on *Refresh* and/or use the *View Extents* command after importing.

Where Pole Data is entered and the 'Station/Pole ID' column is empty or in the case of a DXF file, pole IDs are automatically assigned.
NOTE: Pole IDs must be unique identifiers.

DXF file – Ground Line/Pole Profile

This is a 'Drawing Exchange File' (*.dxf*), as created within an *AutoCAD*™ drawing using the *Export* or *dxfout* command. To load a DXF, the user will need to nominate the file name, applicable scales and the layers containing 'groundline profile' and 'poles', as shown. Be sure when creating the DXF that only Ground Line data, in the form of lines or polylines, is on the nominated 'groundline profile' layer and only Pole data is on the nominated 'poles' layer.



Delimited Text Files - Easting(*x*)/Northing(*y*)/Elevation(*z*)/Station-Pole ID (opt)/Pole Height (opt)/Pole Length (opt)/Pole Sunk (opt)

There is 3 different Delimited Text Files:

1. Comma-Delimited
2. Space-Delimited
3. Tab-Delimited

This is the type of data that may be obtained from a GPS. A typical ASCII text (**.txt*) file for comma-delimited data is shown below. Each line corresponds to one ground point, with the coordinates and station ID separated by commas. Each line is terminated with a carriage return.

3005.2, 1002.4, 10.4, P1,11,13,2	-Pole 'P1' Height 11, Length 13, Sunk 2
3101.3, 1009.9, 14.2, WP2 Road CL	-Remarks 'WP2 Road CL
3180.0, 1020.7, 9.2, WP3 stream	-Remarks 'WP3 stream'
3220.2, 1040.8, 13.6	-No remarks or pole data

Space and Tab delimited data is in the exact same format as above, except comma's are replaced by a 'space' or a 'tab'.

Where the data is simply in Chainage and Level format, the Chainage may be in the *Easting* column, the *Northing* column set to 0 and the Level data entered into the *Elevation* column.

The 'Station-Pole ID' column serves two purposes: if pole details are entered then the Pole ID is stored in this column, otherwise, Station ID or any other remarks may be appended to this column, eg Stn 5, or Fence

Note that 'comma-delimited text' may be extracted from an *Excel*™ spreadsheet by saving as a Comma Delimited Text (**.cvs*) file, then renaming the file so that it has extension **.txt*.

<u>Excel File - Easting(*x*)/Northing(*y*)/Elevation(*z*)/Station-Pole ID (opt)/Pole Height (opt)/Pole Length (opt)/Pole Sunk (opt)</u>

	A	B	C	D	E	F	G
1	0	10	1	Creek			
2	10	20	2				
3	20	30	3	P1	9	11	
4	30	40	4	Fence			
5	40	50	5	P2	11		
6	50	60	4				
7	60	70	3	P3	9		2
8	70	80	2				
9	80	90	1	P4	11		

This data is similar to above, but contained in an *Excel* spreadsheet, as shown above.

<u>Excel File - Easting(*x*)/Northing(*y*)/Elevation(*z*)/Station-Pole ID (opt)/Pole Height (opt)/Pole Length (opt)/Pole Sunk (opt)/Segments (opt)</u>

This data is similar to above, the difference is that *Segment* data maybe added to the second sheet in the *Excel* file.

The first rows of both sheets contains the headings for the columns (ie no data is read in from the first row).

	A	B	C	D	E	F	G
1	**Easting**	**Northing**	**Elevation**	**Station/Pole ID**	**Height**	**Length**	**Sunk**
2	0	10	1	Creek			
3	10	20	2				
4	20	30	3	P1	9	11	
5	30	40	4	Fence			
6	40	50	5	P2	11		
7	50	60	4				
8	60	70	3	P3	9		2
9	70	80	2				
10	80	90	1	P4	11		

The *Stringing Details* are calculated as follows:

- If *%CBL* is entered than this value is used.
- If *Std Tens* is entered than this value is used (ie no %CBL entered).
- If a *Table* is entered than this value is used (ie no %CBL or Std Tens entered).

The *Conditions* refer to those entered in Options (refer section 4.7).

	A	B	C	D	E	F	G	H
1	**Conductor**	**Num Conds**	**%CBL**	**Std Tens**	**Table**	**Conditions**	**Poles**	**AttachHts**
2	MO	3	5			1,2	P1	9
3							P2	11
4							P3	9
5							P4	11
6	LVABC95	1		2		1,2	P1	7
7							P2	9
8							P3	7
9	LVABC95	1			440	1,2	P3	7
10							P4	9

Checks are completed to ensure that the *Poles* and *Conductors* exist before adding the segment data. If they don't exist then a message will inform the user and the particular segment will not be added.

<u>Excel File - Easting(*x*)/Northing(*y*)/Elevation(*z*)/Station-Pole ID (opt)/Pole Height (opt)/Pole Length (opt)/Pole Sunk (opt)/Segments (opt) with Constructions</u>

This data is similar to above, the difference is that *Structures* are added and conductors are attached to *Constructions.*

The first rows of both sheets contains the headings for the columns (ie no data is read in from the first row).

	A	B	C	D	E	F	G	H	I	J
1	**Easting**	**Northing**	**Elevation**	**Pole/Structure/Station ID**	**Structure**	**Height**	**Length**	**Sunk**	**Constructions**	**Attach Hts**
2	0	0	0	P1	WP12.5/12	10	12.5	2.5	11T	9.85
3									LVT	7
4	50	0	1	P2	WP12.5/12	10	12.5	2.5	11TD	9.85
5									LVP	7
6	100	50	2	P3	WP12.5/12	10	12.5	2.5	11TD	9.85
7									LVP	7
8	150	50	5	P4	WP12.5/12	10	12.5	2.5	11TD	9.85
9									LVP	7
10	200	50	-3	P5	WP12.5/12	10	12.5	2.5	11T	9.85
11									LVT	7

The *Stringing Details* are calculated as follows:

- If *%CBL* is entered than this value is used.
- If *Std Tens* is entered than this value is used (ie no %CBL entered).
- If a *Table* is entered than this value is used (ie no %CBL or Std Tens entered).

The *Conditions* refer to those entered in Options (refer section 4.7).

	A	B	C	D	E	F	G	H
1	**Conductor**	**%CBL**	**Std Tens**	**Table**	**Conditions**	**Poles**	**Constructions**	**Con Att Ht**
2	MO		2		1,2	P1	11T	9.85
3						P2	11TD	9.85
4						P3	11TD	9.85
5						P4	11TD	9.85
6						P5	11T	9.85
7	LVABC95	5			1,2	P1	LVT	7
8						P2	LVP	7
9						P3	LVP	7
10						P4	LVP	7
11						P5	LVT	7

Checks are completed to ensure that the *Poles, Structures, Constructions* and *Conductors* exist, *Constructions-Construction Attachment Height* combinations are valid, and that all constructions in the segment are of the same *Voltage* and have the same number of *Conductor Attachment Positions.*
If not all these checks are met then a message will inform the user and the particular segment will not be added.

Checks are also completed to ensure that the start and end poles/structures in segments are *Strain* constructions and that all poles/structures between ends are *Intermediate* constructions.
If these are not met then a warning message is displayed.

<u>Excel File – Distance/Bearing/Incline/Station-Pole ID (opt)/Pole Height (opt)/Pole Length (opt)/Pole Sunk (opt)</u>

	A	B	C	D	E	F	G
1	0	10	50	P1	11		
2	10	20	60	P2	10	2	
3	20	30	70	fence			
4	30	40	80		10		6
5	40	50	90	gully	11		
6	50	60	110		10		
7	60	70	120	hill			
8	70	80	130	P4			
9	80	90	140	P5	11		

Data obtained from Laser Devices may come in Distance, Bearing and Incline form. Where Distance is the direct distance in metres, Bearing is true bearing in the range (0 to 360°) and Incline is in the range (0° to 180°).

Chainage/Level Text File

The input data is contained in an ASCII text file (**.txt*) in the following format:

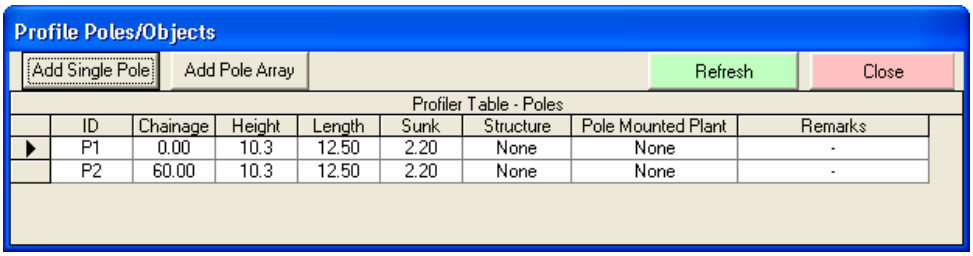
3	(Number of ground line points to follow)
0	(Point 1 Chainage)
1	(Point 1 Level)
30	(Point 2 Chainage)
-1.4	(Point 2 Level)
60	(Point 3 Chainage)
-1.1	(Point 3 Level)

The points will automatically be entered into the GL data grid.

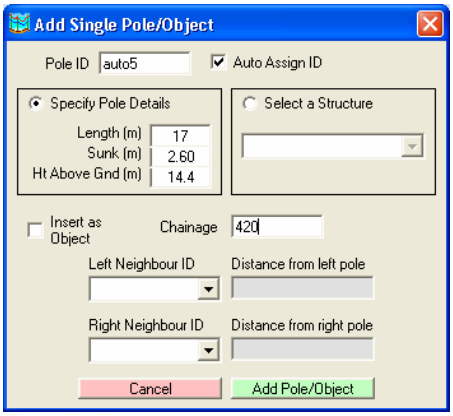
9.3 Entering and Editing Poles/Structures

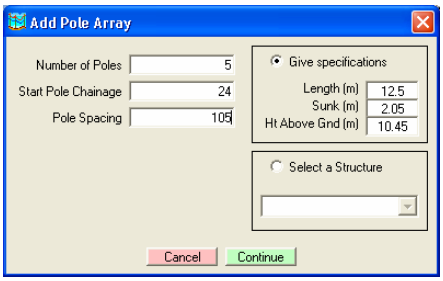
Once the ground line is entered, poles may be added.

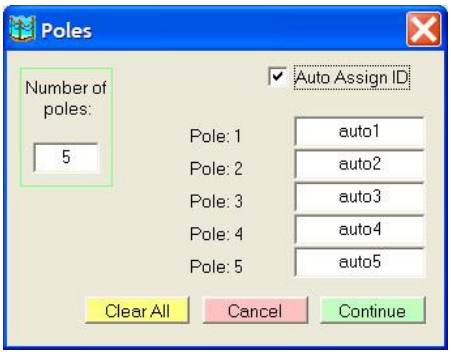
Adding a Pole



To add poles, use the *Insert Single Pole* or *Insert Pole Array* commands, as shown below. Where pole IDs are not known at the time of design, the *Auto Assign* box may be checked, so that pole IDs are automatically assigned to each pole entered in sequence: auto1, auto2,…etc.

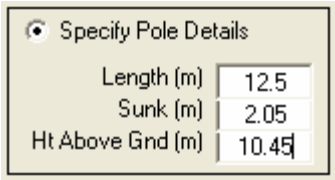




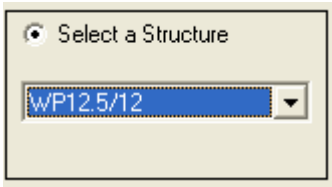


Poles maybe specified in one of two ways:

(i) by entering the Length and Sinking Depth of the pole (Ht Above Gnd will be automatically calculated), or



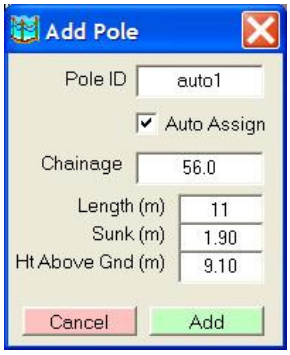
(ii) if there are structures entered into the *Structures Database* (see section 14), then the *Structure* may be selected. This will use the details of the structure from the database.



For single pole entry, chainage may be entered directly, or the distance of the new pole to the left or the right of an existing pole.
For an array of poles, the starting chainage is entered as well as the spacing between poles.

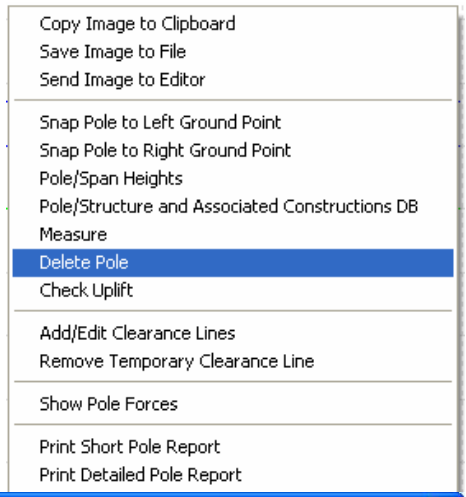
After adding new poles, click *Refresh* to re-draw the display with the amendments.

Another method of pole entry is *Insert Pole* on the drawing toolbar on the right side of the screen. The user 'clicks' on the profile at the chainage at which a pole is desired, then enters pole data as shown.

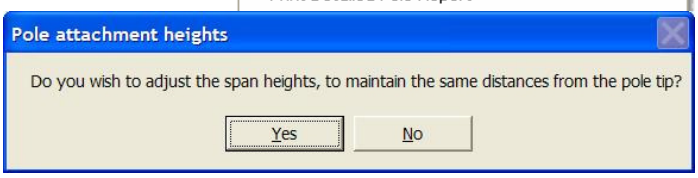


You may also wish to enter 'poles' to represent structures that the line crosses having a known height, even though these are not actually supports for the line you are designing. In this way you will be able to check clearances from the line to the structure using the *Measure* function (see section 9.8).

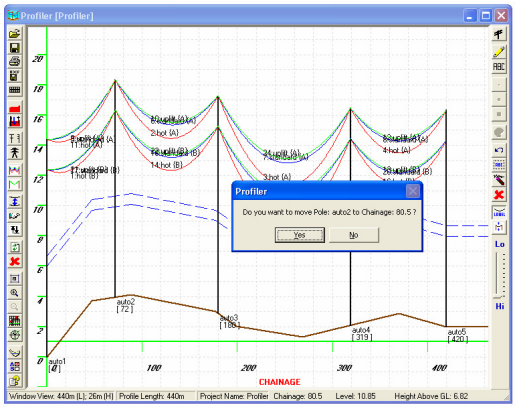
To remove a pole, click on the square to the left of the relevant line in the data grid (pole table), then press the *Delete* key on your keyboard, or right click on the pole and choose *Delete Pole*.
Note: Should you delete a pole to which circuits are attached, you will also delete all the attached circuits. Segments will automatically adjust to any change however you may need to adjust manually entered strain sections and other details of the remaining circuits. If you modify pole position, the program will recalculate the sags for all affected circuits.



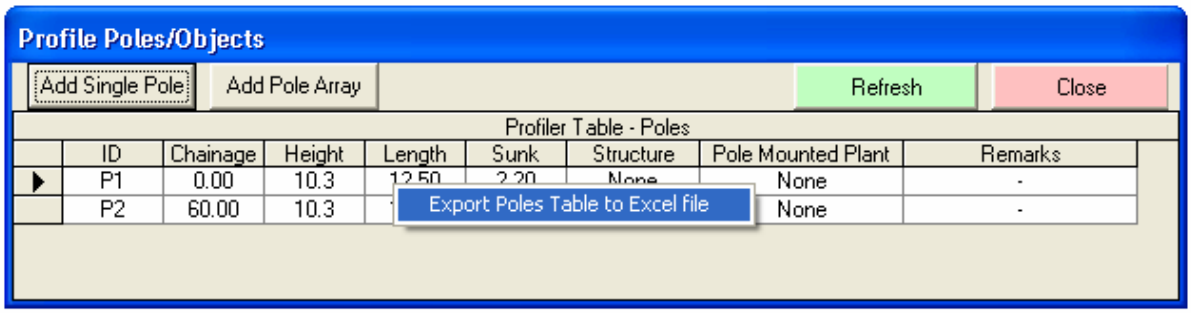
If you modify pole height, the program will ask you how you wish to adjust the attachment heights of all attached circuits.



When the cursor is placed over the pole and the left mouse button clicked whilst holding down the *Shift* key, the pole can then be dragged left or right to a new location. Once the mouse button is released the pole will be set to this new position and circuits will adjust to suit the change. This functionality can be turned on/off in *Options* (refer section 4.7).

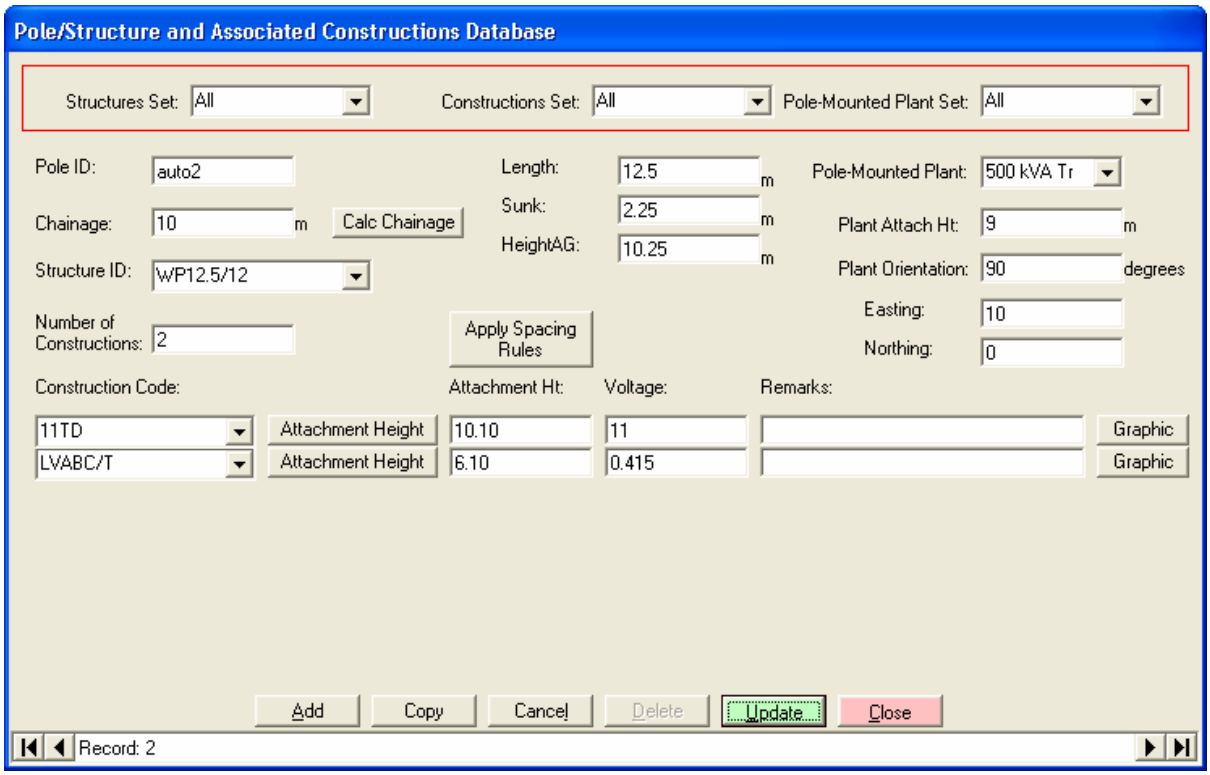


The *Profile Poles/Objects* table may be exported to Excel by right clicking and choosing *Export Poles Table to Excel file*.



Adding a Pole/Structure

To add poles/structures, use the *Pole/Structure and Associated Constructions Database*.



The Default Working Set is loaded from *Options* (refer section 4.9) into the 3 filter combo boxes (structures, constructions and pole mounted plant). These filters are used to load the corresponding lists for use in the form.

Where pole IDs are not known at the time of design, the *Auto Assign* box may be checked, so that pole IDs are automatically assigned to each pole entered in sequence: auto1, auto2,…etc (once the pole/structure has been updated, the *Auto Assign* box disappears).

Chainage may be entered directly, or the distance of the new pole to the left or the right of an existing pole (by clicking on the *Calc Chainage* button).

The Easting and Northing fields are provided for the displaying of Planview (see sections 9.20 and 9.25). These fields will be overwritten with Easting = Chainage and Northing = 0 if a pole is moved or it's chainage changed. These values are imported with the applicable import files (see section 9.2).

The values for *GL Diameter, Pole Length, Height* and *Sunk* are loaded from *Options* (refer section 4.1) and can be changed manually.
Alternatively, a *Structure* may be selected from the list (which will load the GL Diameter, Pole Length, Height and Sunk). However, if a structure has been selected and the Pole Length changes then the structure will be deselected (ie set to 'None') (as it will no longer match the structure parameters).

Pole-Mounted Plant items may be allocated as well as their attachment height and orientation (these values are transferred to the Tip Loads module (refer section 9.24)), defaults to 'None'.

To add *Constructions*, first enter the *Number of Constructions* and then select the *Constructions* from the lists. The *Attachment Heights* are loaded from the *Conductor Attachment Height Rules* in *Options* (refer section 4.7) if a file is selected otherwise they are loaded from the *Nominated Reference Position* in the *Constructions Database*. The *Voltage* (line-to-line) and *Remarks* are also loaded from the *Constructions Database*. The *Attachment Heights* may be manually updated by changing the value in the textbox or by clicking on the *Attachment Height* button, or alternatively clicking on the *Apply Rules* button to apply the *Attachment Height Rules* (this will apply to all Constructions). The *Remarks* may also be manually changed.

To add extra *Constructions* to the Pole/Structure, increase the *Number of Constructions* (this will add the new Construction(s) to the end of the list).

Note: The more than one of the same construction cannot be attached to the same pole/structure at the same attachment height.

To sort the *Constructions* by attachment height, ensure all attachment heights are in the order that the constructions should appear on the pole/structure and click on the *Apply Rules* button. Even if no *rules file* is selected in *Options* (refer section 4.7), the Constructions will be sorted into descending order (from the top of the pole down). If a *rules file* exists, then the *Attachment Heights* will also be amended according to the spacings nominated in the file.

A *Graphic* button is located at the end of each row of Constructions. This button will display an image of the construction, if available, as selected in the *Constructions Database* (refer section 15).

To delete Constructions at the bottom of the list, simply reduce the *Number of Constructions* on the pole/structure (this will remove the excess constructions). To delete constructions not appearing at the end of the list, select *Remove Construction* from the relevant Construction combo boxes.

Note: Deleting constructions will also delete those Segments that contained those constructions.

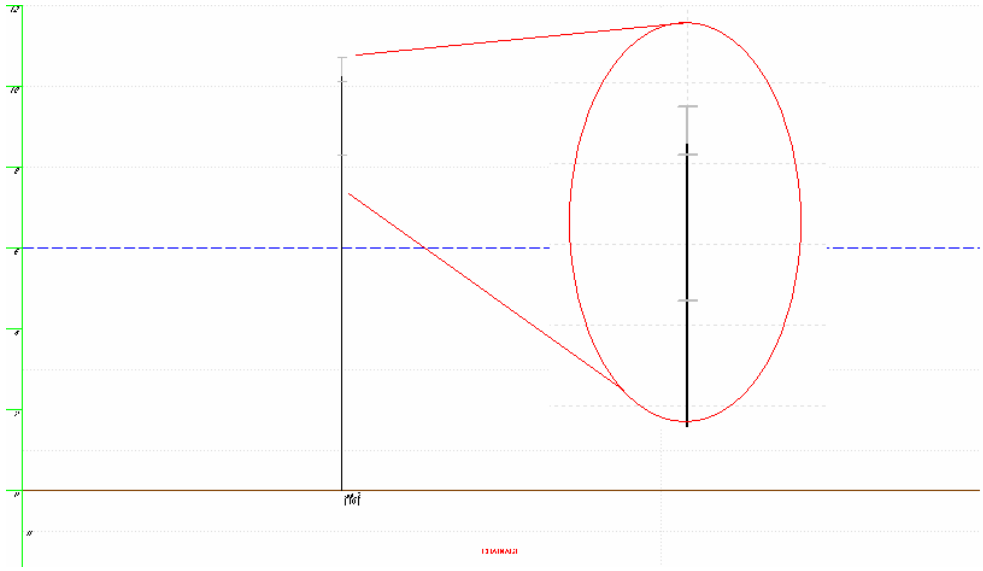
To change a *Construction*, simply select the new construction from the combo box. If the construction has been used as part of a *Segment* then changing the construction will change the segment also according to the following rules:

- If the construction was a strain construction and was replaced by a similar strain construction (same voltage, same number of attachments), then the attachment height will stay the same and the change will be reflected in the corresponding segments.
- If the construction was an intermediate construction and was replaced by a similar intermediate construction (same voltage, same number of attachments), then the attachment height will stay the same and the change will be reflected in the corresponding segments.
- If the construction was a strain construction and was replaced by a similar intermediate construction (same voltage, same number of attachments), then the attachment height will stay the same. However if the segment parameters on both sides of the construction match then they will be combined (if multiple exist then a window will open asking the user which segments to combine). If they do not match, then those segments will be deleted.
- If the construction was an intermediate construction and was replaced by a similar strain construction (same voltage, same number of attachments), then the attachment height will stay the same however the segment will be split into two.
- If the constructions are not compatible (ie different voltage or different number of attachments) then the segments corresponding to them will be deleted.

If no segments are attached to the construction, then no additional changes will be made.

Note: Be very careful in changing constructions, as this will affect the circuit segments that they are a part of.

Once all pole/structure parameters are entered, click *Update* to update the *Profile*. The conductor attachment points on the pole are shown with a horizontal grey line and if the attachment point is above the pole tip then a vertical grey line extends from the pole tip to the conductor attachment point.

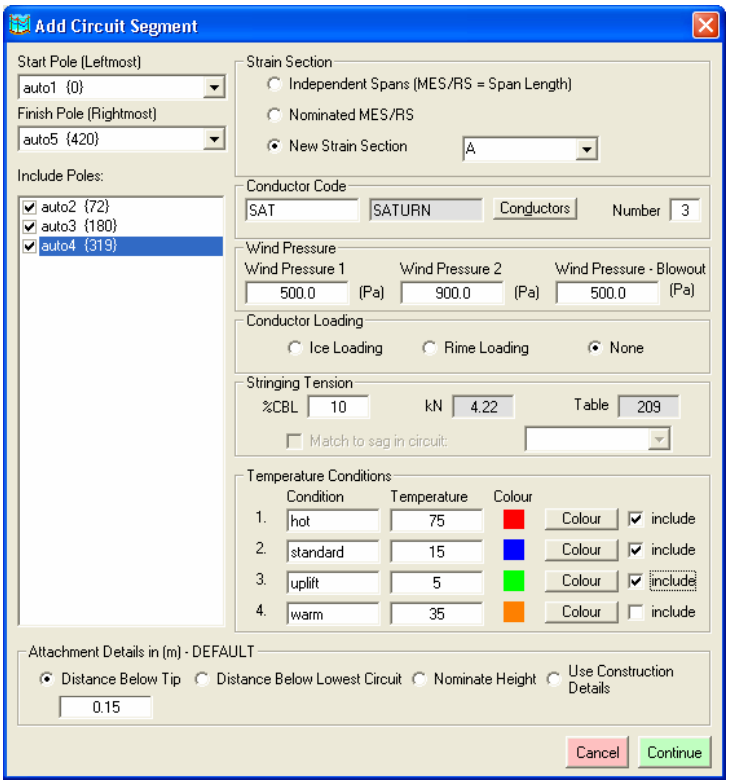


9.4 Entering Circuit Spans

Once the pole details are entered, circuits (spans of conductor/cable) can be entered.

Adding a Circuit Segment

To create a *circuit segment*—single or multiple spans at single or multiple temperature conditions—click on the *Add/Edit Circuit Segments* icon, then click on then *Add* button.

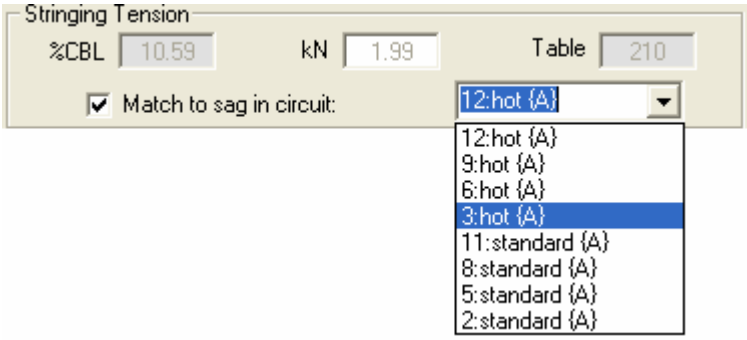


The user should nominate the left and right poles from the list boxes. The intermediate poles to which the conductors attach should be checked.

The user should nominate conductor type, stringing tension and which temperature conditions are to be modelled. Default circuit colours, labels, temperatures and the number of conductors are loaded from *Options* (refer sections 4.4 and 4.7), but these may be changed within the *Add Circuit Segment* form.

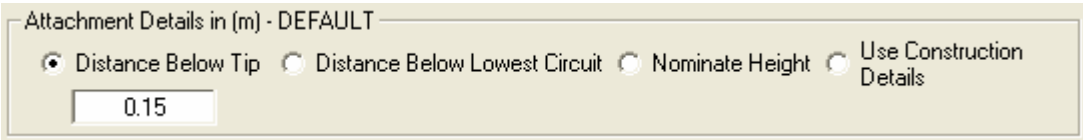
If *Circuit Spans* already exist, then it may be possible to match the sag of the new

circuit segment with that of an existing circuit. If such a span exists than it shall be loaded into the following drop down list. To use this feature: check the *Match to sag in circuit* box and select the *circuit*. This feature works by back calculating the stringing tension from the sag for the new conductor.



Four options are available for **circuit attachment height** (Attachment details in metres - Default):

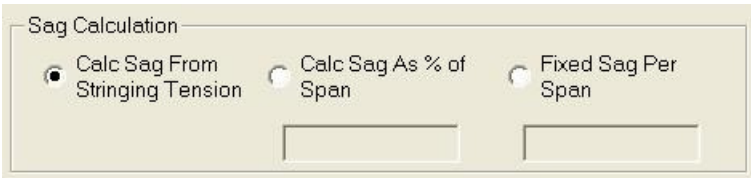
(i) a nominated distance below the pole tip,
(ii) a nominated height above ground, or
(iii) a nominated distance below the bottom circuit on the pole, or if there are no circuits already present, the distance below the pole tip, or
(iv) the heights entered into the *Constructions Database* (refer section 15).



(Note: Defaults for i, ii and iii above are loaded from Options)

There are three options for the handling of MES/RS:

(i) independent spans, ie a strain point on each pole, so that for each pole the MES is equal to the span length
There are three options for handling the sag of independent spans:
   a. Use sag calculated from the Stringing Tension
   b. Use sag as a percentage of the span length
   c. Use a set sag



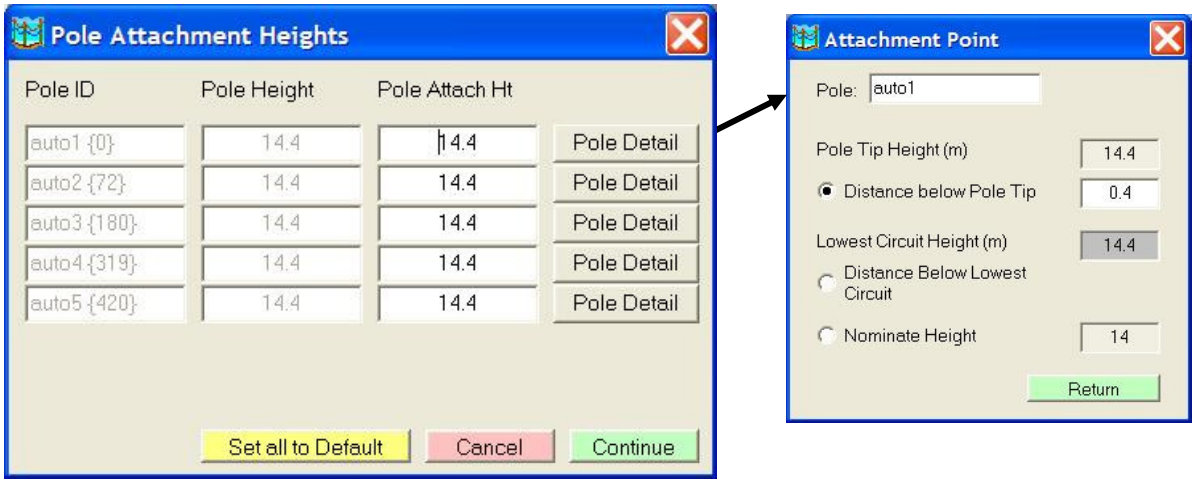
(ii) a fixed MES nominated for all spans in the section

(iii) establish the strain section as just that – a new strain section, with strain points at each end and MES/RS calculated based on the various span lengths within the segment. The program defaults to a new strain section for each Segment that is entered.

It is possible to select an existing strain section and add to it. Where this occurs, the program automatically loads conductor type, stringing tension and temperature conditions as per previous circuit spans within the strain section.

Once the 'Continue' button is clicked, the 'pole attachment heights' form is displayed, where the attachment heights for the segment can be amended. This form is pre-loaded with the general options from the 'Add Segment' form.

<u>Non-Constructions (circuit attachment height (i)(ii)(iii))</u>
The pole details of each pole can be accessed at any time by clicking on the 'pole details' button directly to the right of the desired pole. Once the user had completed all the attachment details then the 'Continue' button can be clicked, the segment can be created and added to the profile.

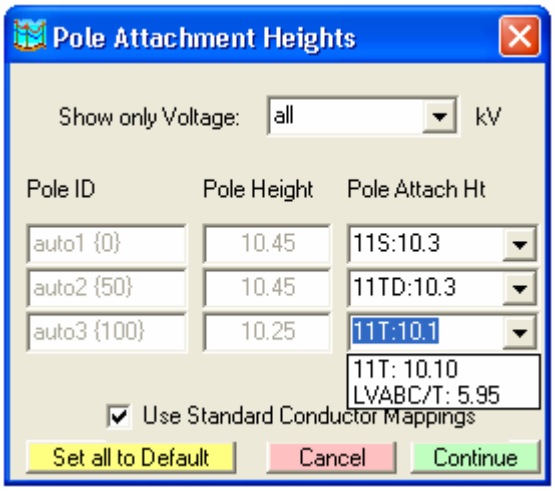


Clicking on the *Set all to Default* button will set all pole attachment heights to the values calculated from the defaults entered in the *Add Circuit Segment* form.

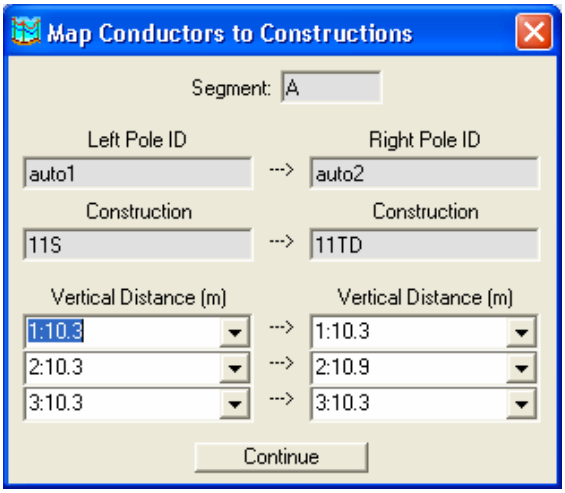
Clicking on *Continue* in the 'Pole Attachment Heights' form, will create the segment and update the screen plot.

Constructions (circuit attachment height (iv))

If all poles/structures selected contain construction(s) then the *Pole Attachment Heights* are not entered as a height in metres, the construction is selected instead. If more than 1 voltage level is present on the poles/structures selected then a voltage filter is shown and the constructions can be filtered by there voltage (line to line). Constructions can then be selected by there code and attachment height.

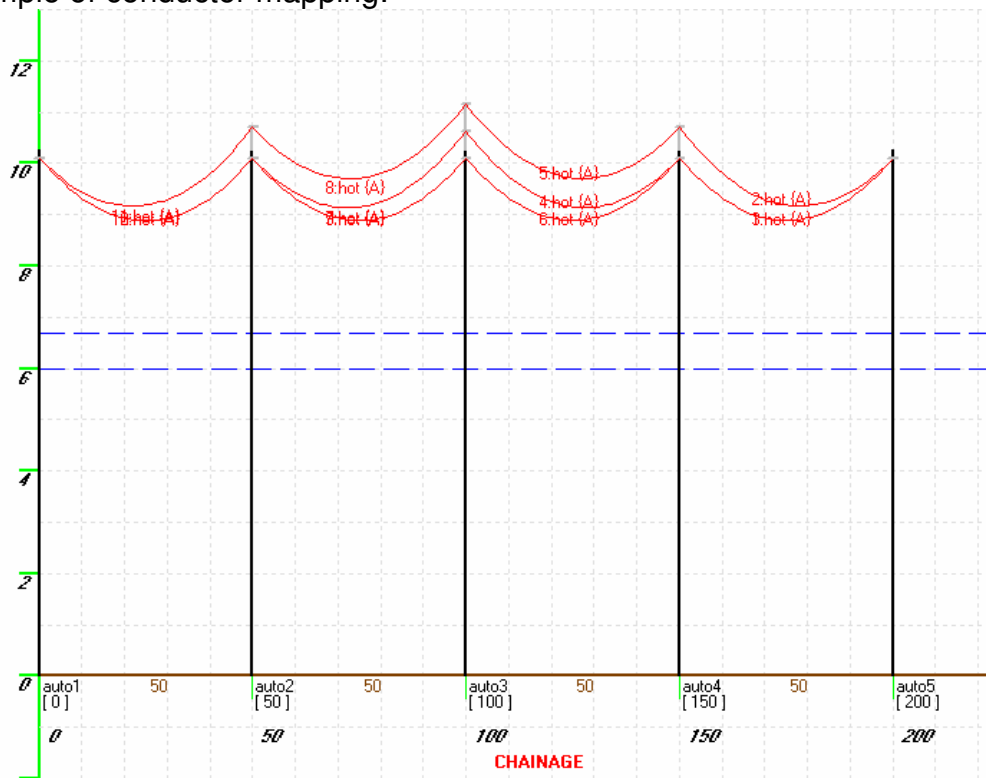


The *Use Standard Conductor Mappings* checkbox is also displayed. This allows the conductors to be mapped from attachment point on the left construction to the attachment point on the right construction (useful for transposition and non-flat constructions). When the box is checked, the conductors are mapped according to the positions that they are entered in the *Constructions Database* (refer section 15), otherwise the following form is displayed.

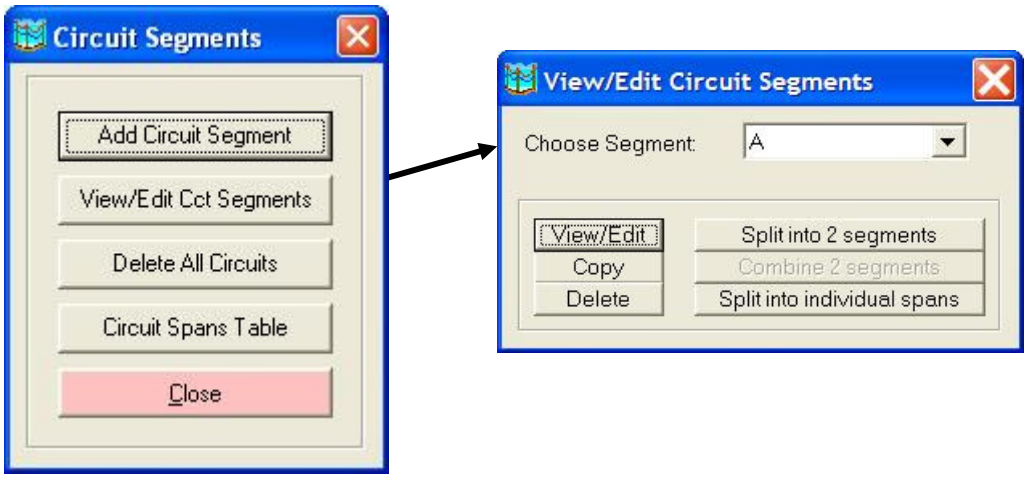


In this form, individual conductors can be mapped according to user preference.

An example of conductor mapping:



Copy, Edit or Remove Circuit Segments



The 'View/Edit Circuit Segments' utility can be launched to view and/or edit Segments as an entity, copy segment parameters, and may also be used to delete segments.

View/Edit loads the current segment's parameters, where they can be viewed and/or changed as required.

To copy a segment, scroll through the segments to locate the one you wish to copy.

Click on *Copy* to create a new segment with the same parameters, which may then be edited.

To remove a segment, scroll through the segments to locate the one you wish to delete, and click on *Delete.*

If a segment contains more than two poles then it can theoretically be split into two sections if desired. To accomplish this: scroll through the segments to locate the one you wish to split and click on *Split into 2 segments*.

The above window will appear, where you may choose the common pole of the two segments (pole at which termination or shackle will occur), then click on continue to split the segment into two.
Note: To split segments consisting of *constructions*, use the *Pole/Structure and Associated Constructions Database* to change the intermediate construction to a compatible strain construction (refer section 9.3).

The reverse of this is also possible, that is combining two segments into one. Scroll through and select the first(leftmost) segment. If there is a valid segment to combine with (ie. similar parameters) then the *Combine 2 Segments* button will be enabled, click this button and select the segment to combine with and click on Continue to combine the two segments.

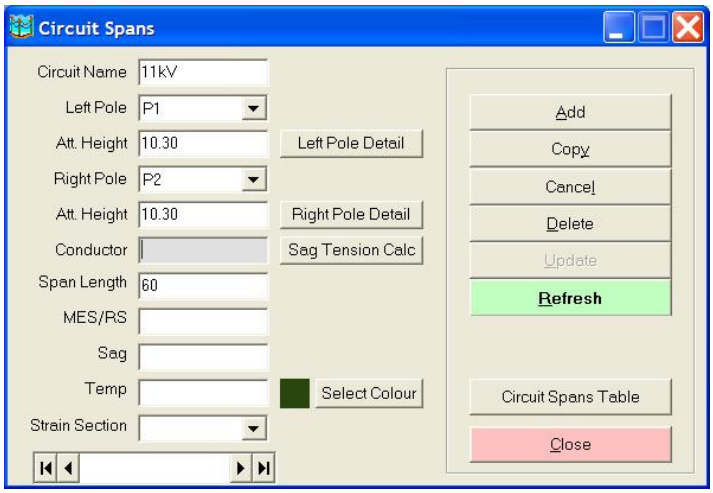
Note: To combine segments consisting of *constructions*, use the *Pole/Structure and Associated Constructions Database* to change the strain construction to a compatible intermediate construction (refer section 9.3).

Split into Individual Spans, allows the user to split the current segment into totally individual spans where they can only be edited in the Circuit Spans form or Circuits Table. This is a pretty drastic function and shouldn't be used lightly, once chosen this process cannot be reversed.

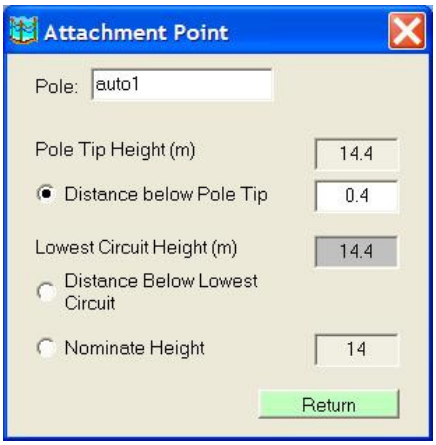
Note: Not available to segments consisting of *constructions*.

In some instances, users may wish to generate/edit individual spans or view/edit profiles created in earlier versions.

<u>Adding a Circuit Span</u> (Retained for backward compatibility (from Version 1.0))



To create a *circuit span*—a single span at a single temperature condition—click on the *Add/Edit Single Spans* icon, then click on the *Add* button. You may enter a circuit name to differentiate it from other circuits, eg “11kV”, or “75C” or “uplift”. The circuit label displayed on the screen consists of the circuit number (allocated sequentially), circuit name and strain section, eg “2:33kV hot {B}”. Circuit labels can be toggled on and off on the display using the button on the Drawing toolbar at the right side of the profile screen.

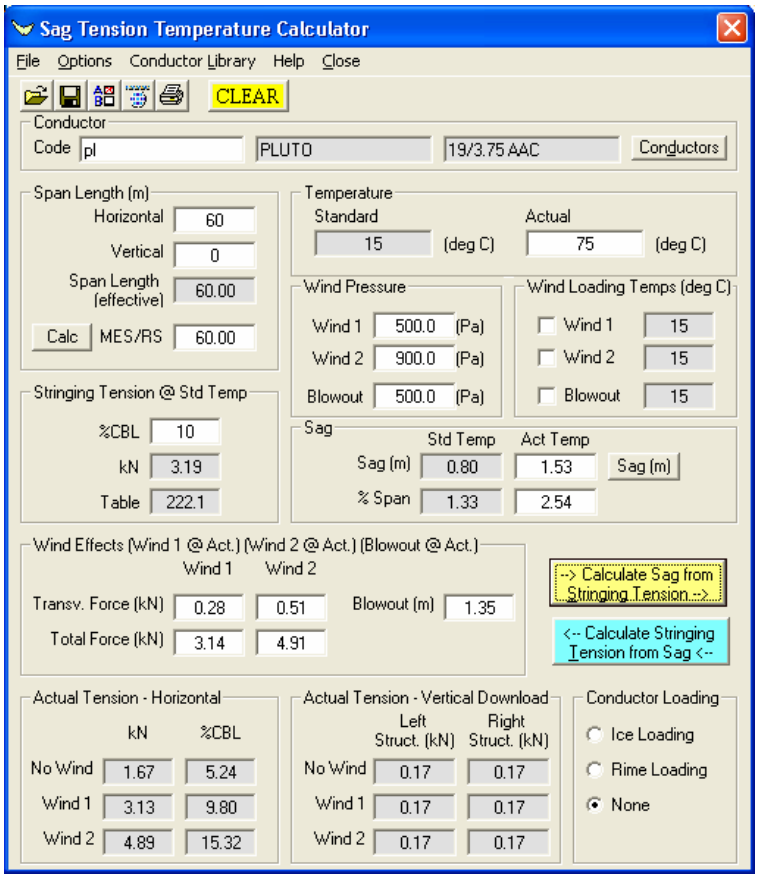


You must enter valid pole IDs supporting the circuit at the left and right ends. Select from the list of available poles.

For each pole you must enter an attachment height. This will default to the top of each pole, but alternatively, you may wish to enter the distance of the circuit below the pole tip, or below the bottom circuit on the pole. To do this, click on the *Left Pole Detail* and *Right Pole Detail* buttons, then by entering data on the *Attachment Point* form as shown.

Where the sag of the circuit is known, you may enter this directly into the *Circuit Spans* form, without entering details of the conductor.

However, where the sag of the conductor needs to be calculated, click on *Sag Tension Calc* to invoke the *Sag-Tension-Temperature* module. The form is pre-loaded with the span length (horizontally and vertically), calculated from the differences in chainage of the two supporting poles and the circuit attachment heights. Enter the conductor type, temperature and stringing tension and then click on the *Calculate Sag from Stringing Tension* button.



If sag is known then it can be directly entered or entered as a percentage of the span length, then the stringing tension can be calculated by clicking on the *Calculate Stringing Tension from Sag'* button.

On exiting the *Sag Tension Temperature* module, all circuit parameters are copied across to the *Circuits* form.

You may nominate a colour for the circuit using the colour palette, eg red for hot, blue for standard temperature, green for uplift.

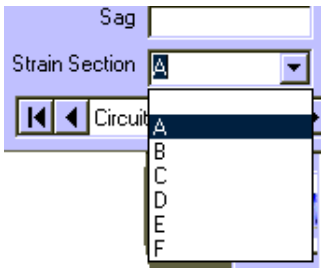
Once the circuit details are entered, click *Update*.

You may edit any of the parameters for the current circuit, but will need to click on *Refresh* to re-draw the display with the amendments.

Generally upper circuits are entered first, working down the pole to subcircuits.

MES/RS will generally default to the horizontal span length, unless otherwise specified by the user in the *Sag Tension Temperature* form or the *Circuits* form.

When entering a circuit, you may assign it to a strain section group: A, B, C,… As new spans are added to the strain section, the MES may be altered and, in turn, the sag for each span will be recalculated.



This recalculation will occur each time the screen plot is refreshed – when the *Refresh* button is clicked, when another circuit is drawn, or on exiting the Circuits form. Where no strain section is allocated, the program will assign the strain section value to either:

- Independent 'Ind', if MES equals span length
- Nominated MES 'Nom, if MES is other than span length.

Copy, Edit or Remove Circuit Spans

To copy a circuit, scroll through the circuits to locate the one you wish to copy. Click on *Copy* to create a new circuit based on the selected circuit's parameters, which may then be edited.

After editing a circuit, click on *Refresh* to redraw the screen plot. If pole height is altered, the user may need to edit the affected circuits, setting up new attachment heights.

To remove a circuit, scroll through the circuits to locate the one you wish to delete, and click on *Delete.*

Delete All Circuits

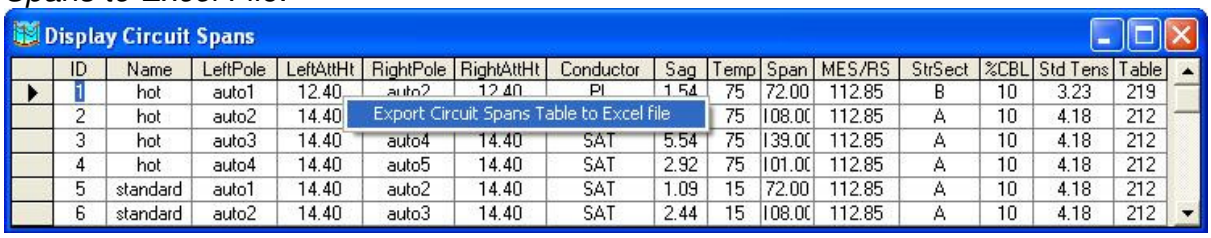
To delete all circuits, click on the *Delete All Circuits* button on the *Circuit Segments* form.

9.5 Viewing Circuits

The circuits may be displayed by scrolling forwards and backwards with the data control at the base of the circuits form, or by clicking the *Circuit Spans Table* button. The circuit properties can be viewed, but not edited in this data table.

ID	Name	LeftPole	LeftAttHt	RightPole	RightAttHt	Conductor	Sag	Temp	Span	MES/RS	StrSect	%CBL	Std Tens	Table
1	hot	auto1	12.40	auto2	12.40	PL	1.54	75	72.00	112.85	B	10	3.23	219
2	hot	auto2	14.40	auto3	14.40	SAT	3.34	75	108.0(	112.85	A	10	4.18	212
3	hot	auto3	14.40	auto4	14.40	SAT	5.54	75	139.0(	112.85	A	10	4.18	212
4	hot	auto4	14.40	auto5	14.40	SAT	2.92	75	101.0(	112.85	A	10	4.18	212
5	standard	auto1	14.40	auto2	14.40	SAT	1.09	15	72.00	112.85	A	10	4.18	212
6	standard	auto2	14.40	auto3	14.40	SAT	2.44	15	108.0(	112.85	A	10	4.18	212

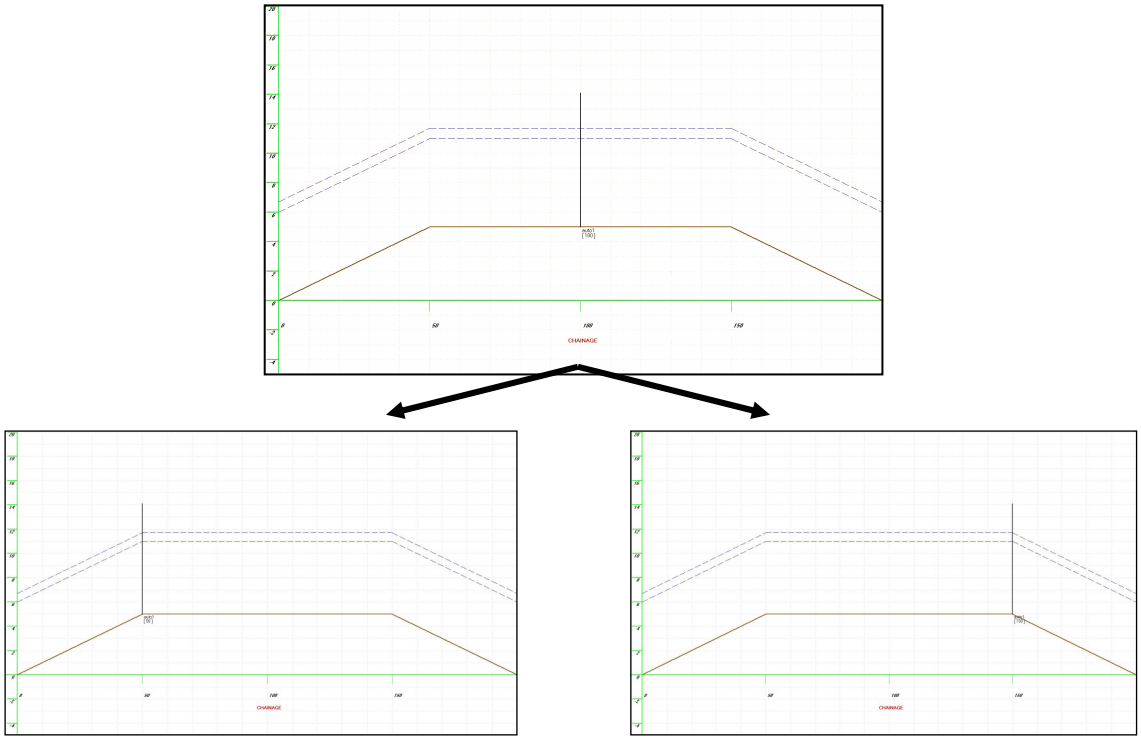
This table may be exported to Excel by right clicking and choosing *Export Circuit Spans to Excel* File.



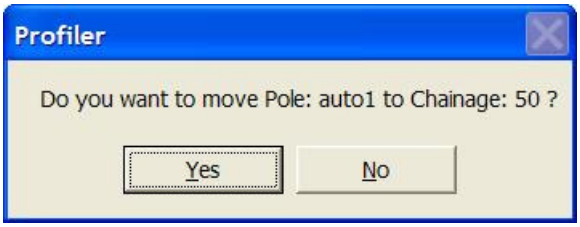
The Circuits in this table may be sorted by double clicking on the column title.

9.6 Snap Pole to Left/Right Ground Point

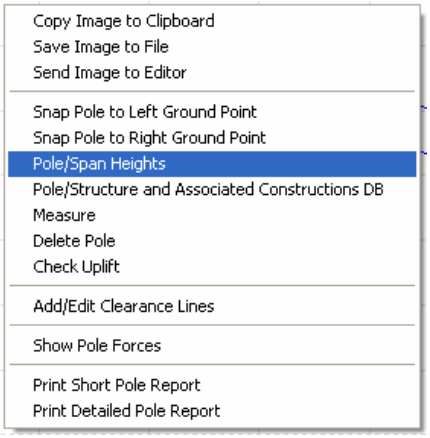
This function is in the right click menu and allows the user to snap the desired pole to either the closest left or right groundline point.

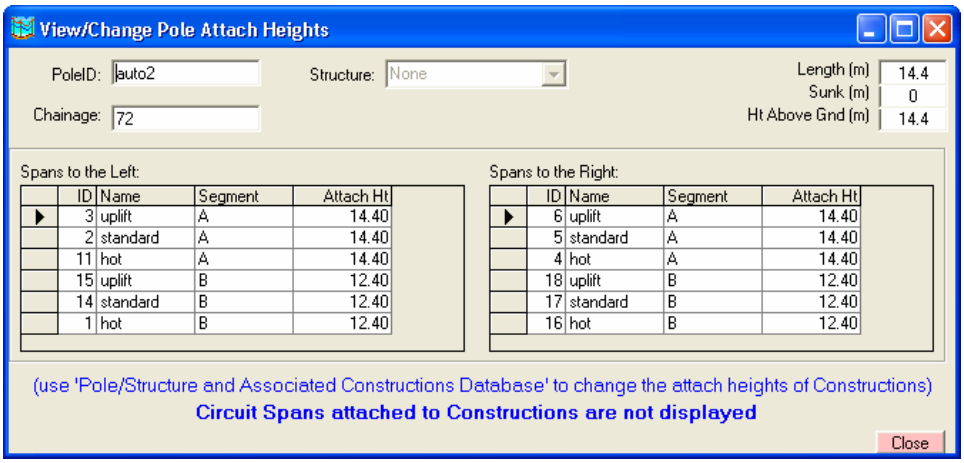


The profile assumes the rightmost visible point to be the last right groundline point, 0 is obviously the last left groundline point and the user is asked before moving the pole.



9.7 Pole/Circuit Spans Form

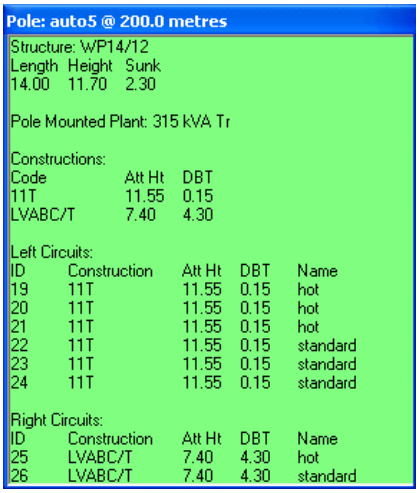


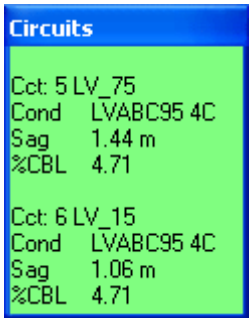


When the cursor is placed over a pole and the right mouse button clicked, the user may select the option *Pole/Span Heights*. This is a link to the View/Change Attachment Heights form. All pole/structure and circuit details are passed on to the new form. Once the View/Change Attachment Heights form has been displayed the user can edit the current poles' circuits' attachment heights, or click on other poles in the profile and change there attachment heights. If more than one circuit is attached at same height, (ie a segment) then associated circuits attachment heights are also updated.

Note: Circuit Spans attached to Constructions are not displayed (use *Pole/Structure and Associated Constructions Database* to change the attach heights of Constructions)

When the cursor is placed over a pole and the left mouse button clicked, the pole ID is displayed along with the structure, height, length, sunk, pole mounted plant, constructions with attach details, followed by all circuits on the pole, there construction (if any), attachment heights and distance from the tip.

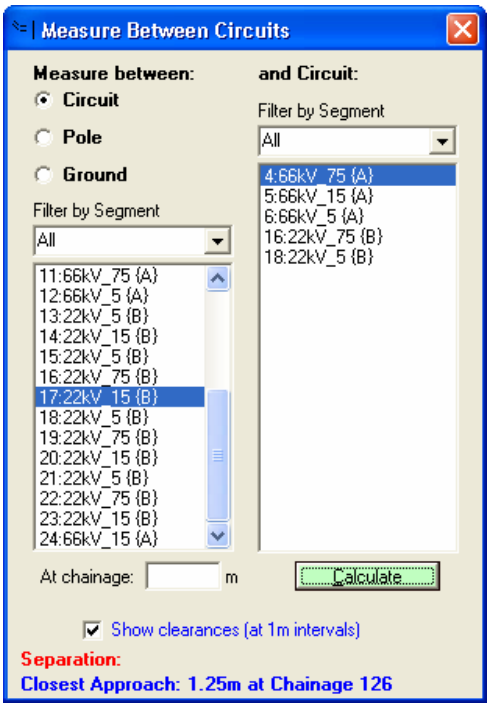




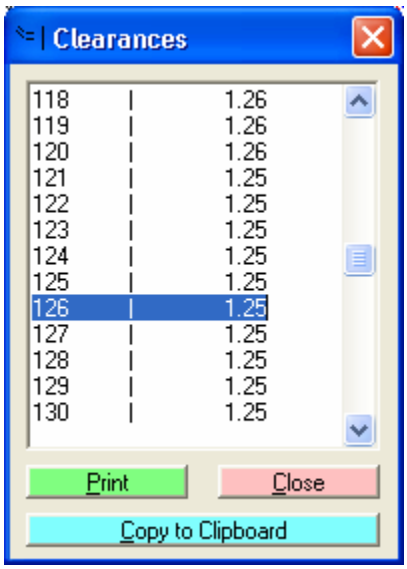
When the cursor is placed over a circuit label and the left mouse button clicked, the circuit IDs (along with their conductor and sag parameters) for all circuits within 1m are displayed.

9.8 Measure Function

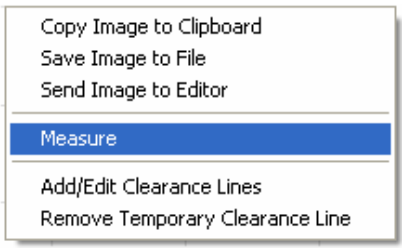
Click on *Measure* to measure the distance between two circuits, a circuit and ground, or a circuit and a pole tip. Measure either at a nominated chainage, or else let the program calculate the minimum clearance.



Details of clearance can be shown at metre intervals if the tick box is checked. These details can then be printed to the *default* printer or copied to clipboard.



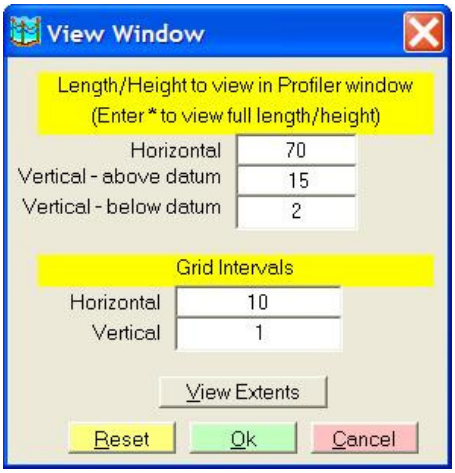
The measure function is also available from right click menu.



NOTE: Measure

function is accurate to ±1 m.

9.9 View Window and Grid Scale



The default screen window size and grid intervals are set in accordance with the Options settings (refer section 4.7).

Click on *the View Window* button to amend the window size/position, or the horizontal or vertical grid intervals.

The *View Extents* command automatically sizes the window to suit the profile length.

The *Zoom In* and *Zoom Out* buttons may be used to control the scaling of the view window. Limits apply to the extent of zooming that is possible. The scroll bars on the window can be used to pan left and right along the profile.

9.10 Shift Profile Right

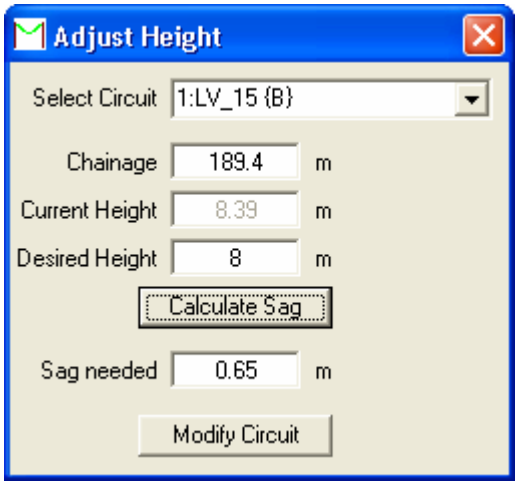
This function moves the entire profile—ground line, poles, circuits and annotations—to the right by the distance nominated by the user. This function is used to insert space at the start of the profile.

9.11 Change Profile Starting Level

This function effectively moves the profile up and down by changing the level at which the profile groundline starts. The distance is nominated by the user and can be adjusted at anytime.

9.12 Change Sag

After a profile has been entered, the sag/tension of a circuit or circuits can be altered to a specific clearance. Click on the *Change Sag* button, which will depress, and then click on the desired circuit at the desired chainage. This will open up the *Adjust Height* form where the circuit can be identified more accurately, the chainage can then be adjusted and the current clearance for that circuit will be displayed. Enter the desired clearance in the *Desired Height* field and click on *Calculate Sag,* this then goes ahead and calculates the required sag/tension based upon the desired clearance, once this is found the user clicks *Modify Circuit* which adjusts the desired circuit to the new clearance.



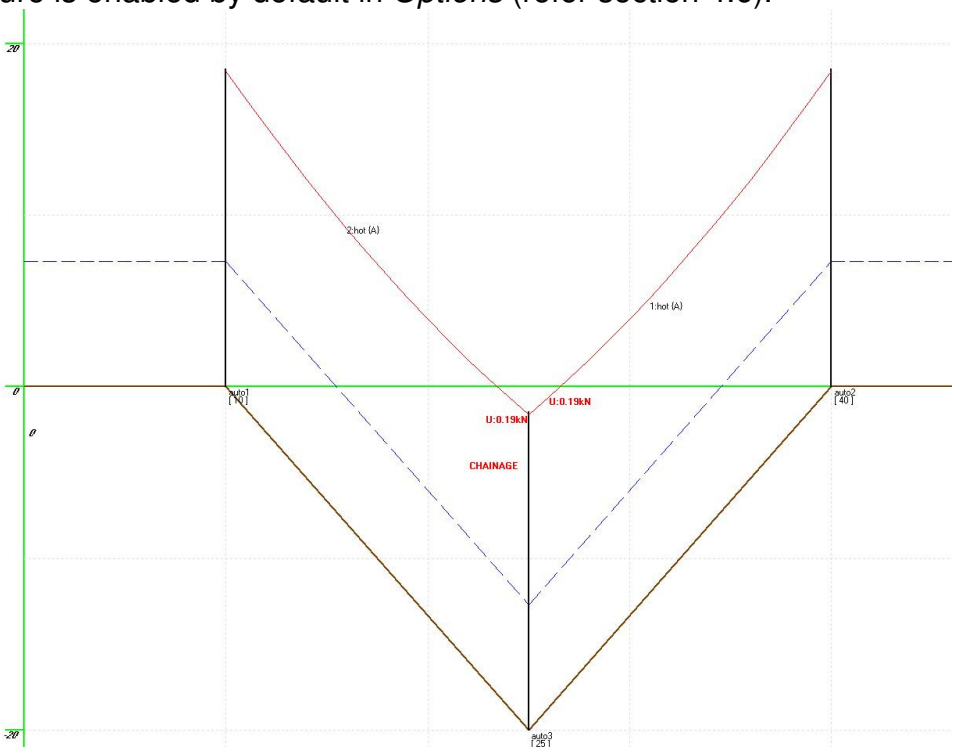
9.13 Uplift Indicator

Possible *Uplift* in the profile is indicated by a red letter U next to the spans(s) that may have uplift. To work out if uplift exists:

- Draw a line from the attachment point to the conductor 1.0m from the pole
- Calculate the angle to the horizontal (An angle >0 denotes uplift)

The kN value is also displayed and is the vertical component of the *Actual Wind Tension* on the conductor, calculated using the angle above.

This feature is enabled by default in *Options* (refer section 4.6).



By right clicking on the pole and choosing *Check Uplift*, a numerical breakdown segment by segment will be shown along with the total uplift for 'No Wind', 'Wind 1' and 'Wind 2' conditions. Uplift is calculated at the temperature specified in *Options* (refer section 4.6).

9.14 Interpreting Profiler Results

You will typically need to check the following conditions to ensure that the line design meets clearance requirements:

(a) maximum (hot) design temperature (eg 75°C) – clearances from ground for lowest circuit. Be sure that the circuit curve does not cross below the clearance line.
(b) uplift (cold, eg 5°C) condition for poles in a hollow or on a steep slope. Uplift is evident when the lowest point of the circuit span is at the pole at the low end rather than a point within the circuit span, ie the span rises immediately adjacent to the pole instead of sagging down. If uplift exists, you will need to use a strain construction or similar, or else alter pole position, increase pole height or reduce conductor tension.
(c) intercircuit clearances – hot temperature (eg 75°C) on top circuit, cool temperature (eg 15°C) for sub-circuit.

9.15 Annotating the Profile

You may wish to annotate the profile to indicate landmarks such as edges of roads, trees, structures, creeks or other features for reference. Profiler contains a rudimentary drawing tool for this purpose. If detailed notes are required, it may be better to export the profile as a DXF to CAD and add these later.

Click on the pencil button to activate line draw mode, then click on the screen at the point where the line starts. Release the left button of the mouse when the cursor is at the point where the line should stop. Line thickness and colour may be set using the neighbouring buttons in the drawing tool bar.

To add text, first click the Text Annotation button, then click on the screen at the point where you wish the text string to start, then enter the text into the input box provided. Text colour may be set using the colour palette.

The last annotation entered may be deleted clicking the *Undo Annotation* button. All annotations may be removed by clicking the *Delete All Annotations* button. A button is also provided to view all text annotations and allow them to be edited.
To delete a line, first click on the Line Delete button, then click on the left end of the line to be deleted.

9.16 Sag Tension Calculator

For convenience a link to the Sag Tension Calculator is located on the left sidebar of the profile. This is in no way linked to Profile data, it just provides a means to access the sag tension calculator if desired.

9.17 Entering a Project Name

Double click on the *Project Name* field at the base of the Profile screen. You may wish to enter the job name, number or location.
If the current study has no project name, on saving, printing or exporting, the user is prompted to enter a project name.

9.18 Exporting the Profile as a Bitmap

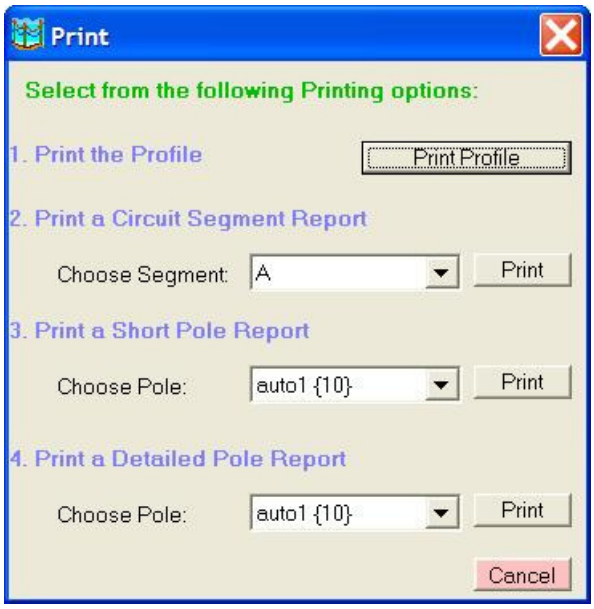
To export the profile as displayed, place the mouse over the screen and click on the right mouse button. You will be given three options:

- Save Image to Windows Clipboard
- Save to File (**.bmp*) nominated by user.
- Send Image to Editor

The bitmap file produced may then be inserted into reports or other design documents or drawings.

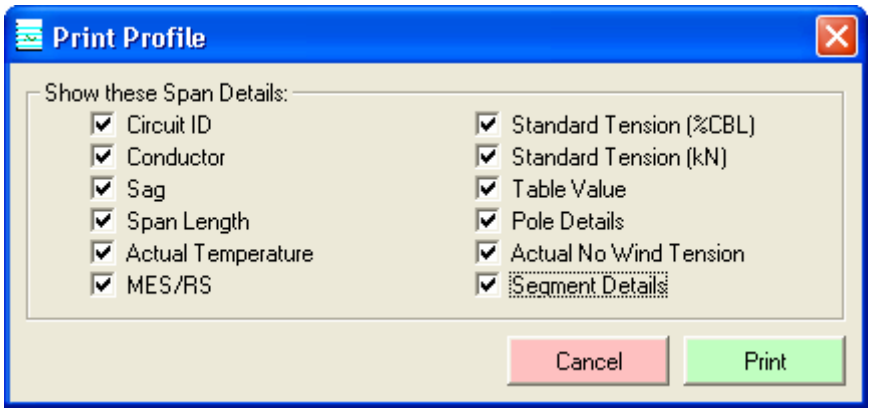
9.19 Printing

There are four options when printing: Print Profile, Print Circuit Segment Report, Print Short Pole Report and Print Detailed Pole Report.



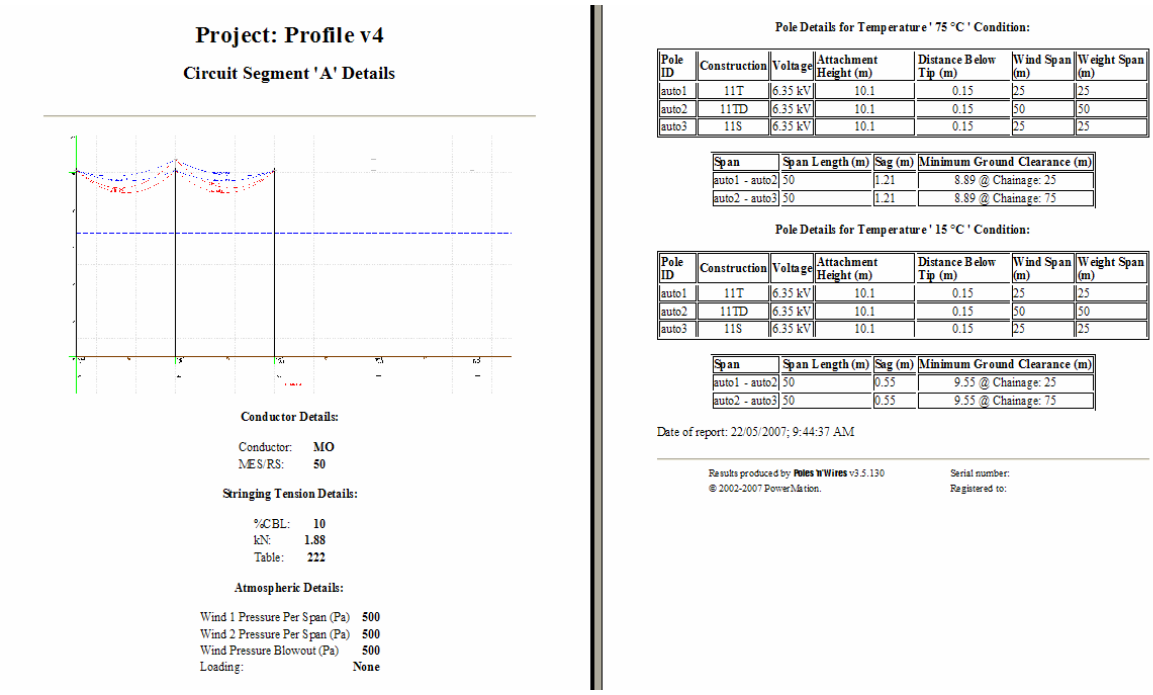
Print Profile

It is recommended that you enter the project name prior to printing out the profile (as described above in section 9.11), but the program will ask for one when printing if one is not present anyway.



The user may nominate which details are displayed and which are excluded using the check boxes on the right hand side of the screen.

Print Circuit Segment Report



Project: Profile v4

Circuit Segment 'A' Details

Conductor Details:

Conductor: **MO**
MES/RS: **50**

Stringing Tension Details:

%CBL: **10**
kN: **1.88**
Table: **222**

Atmospheric Details:

Wind 1 Pressure Per Span (Pa) **500**
Wind 2 Pressure Per Span (Pa) **500**
Wind Pressure Blowout (Pa) **500**
Loading: **None**

Pole Details for Temperature ' 75 °C ' Condition:

Pole ID	Construction	Voltage	Attachment Height (m)	Distance Below Tip (m)	Wind Span (m)	Weight Span (m)
auto1	11T	6.35 kV	10.1	0.15	25	25
auto2	11TD	6.35 kV	10.1	0.15	50	50
auto3	11S	6.35 kV	10.1	0.15	25	25

Span	Span Length (m)	Sag (m)	Minimum Ground Clearance (m)
auto1 - auto2	50	1.21	8.89 @ Chainage: 25
auto2 - auto3	50	1.21	8.89 @ Chainage: 75

Pole Details for Temperature ' 15 °C ' Condition:

Pole ID	Construction	Voltage	Attachment Height (m)	Distance Below Tip (m)	Wind Span (m)	Weight Span (m)
auto1	11T	6.35 kV	10.1	0.15	25	25
auto2	11TD	6.35 kV	10.1	0.15	50	50
auto3	11S	6.35 kV	10.1	0.15	25	25

Span	Span Length (m)	Sag (m)	Minimum Ground Clearance (m)
auto1 - auto2	50	0.55	9.55 @ Chainage: 25
auto2 - auto3	50	0.55	9.55 @ Chainage: 75

Date of report: 22/05/2007; 9:44:37 AM

Results produced by **Poles 'n' Wires** v3.5.130
© 2002-2007 PowerMation.

Serial number:
Registered to:

Select 'all' from the list to print a report containing all segments.

Print Short Pole Report

Select ‘all’ from the list to print a short report containing all poles.

Project: Profile v4

Pole Report (Short)

Pole 'auto1 ' Details

Chainage:	0 m
Structure:	WP12.5/12
Pole Length:	12.5 m
Sunk:	2.25 m
Height above Ground:	10.25 m
Pole Mounted Plant:	None

Circuits Attached

Construction	Voltage	Attachment Height	Distance below tip
11T	5.35 kV	10.1 m	0.15 m
LVABC/T	0.24 kV	8.1 m	2.15 m

Date of report: 22/05/2007; 9:44:46 AM

Results produced by **Poles 'n' Wires** v3.5.130
© 2002-2007 PowerMation.

Serial number:
Registered to:

Print Detailed Pole Report

Select ‘all’ from the list to print a detailed report containing all poles.

Project: Profile v4

Pole Report (Detailed)

Pole 'auto1' Details

Chainage:	0 m
Structure:	WP12.5/12
Pole Length:	12.5 m
Sunk:	2.25 m
Height above Ground:	10.25 m
Pole Mounted Plant:	None

Circuits Attached to Construction: 11T

RightSide

Circuit name	Conductor	Attachment Height	Distance below tip	Wind Span	Weight Span
hot	MO	10.1 m	0.15 m	25 m	25 m
hot	MO	10.1 m	0.15 m	25 m	22 m
hot	MO	10.1 m	0.15 m	25 m	25 m
standard	MO	10.1 m	0.15 m	25 m	25 m
standard	MO	10.1 m	0.15 m	25 m	18 m
standard	MO	10.1 m	0.15 m	25 m	25 m

Circuits Attached to Construction: LVABC/T

RightSide

Circuit name	Conductor	Attachment Height	Distance below tip	Wind Span	Weight Span
hot	LVABC95	8.1 m	2.15 m	25 m	25 m
standard	LVABC95	8.1 m	2.15 m	25 m	26 m

Download due to Conductors (@ 5°C)

Vertical Tension No Wind	Vertical Tension Wind 1	Vertical Tension Wind 2
0.56 kN	0.55 kN	0.55 kN

Date of report: 22/05/2007; 9:47:04 AM

Results produced by **Poles 'n' Wires** v3.5.130
© 2002-2007 PowerMation.

Serial number:
Registered to:

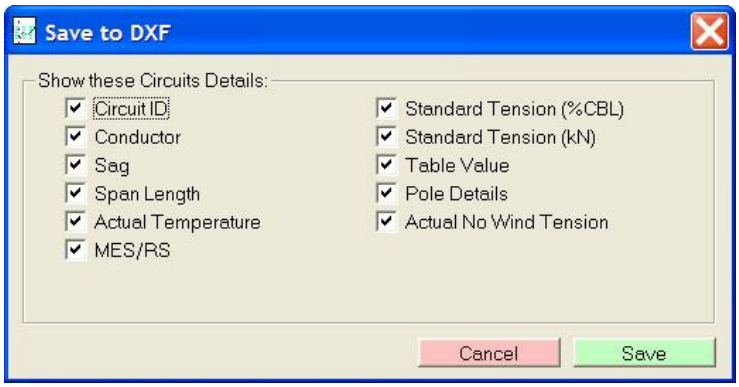
9.20 Exporting to *DXF* File

.dxf file (AutoCAD™ drawing exchange file) format

There are two options where exporting to DXF: a Profile DXF and a Planview DXF.

Profile DXF

You will need to nominate the *.dxf* file name. This is generally best done using the *Browse* function. As for printing a profile, the user may nominate which circuit details are included in the profile using the check boxes provided.



Planview DXF

The Planview DXF gives a planview of the profile. It draws poles in as a small circle and includes blowout. The blowout is calculated at the designated temperature from *Options* (refer section 4.2) if selected else it asks for it. It then draws in the blowout for each span.

NOTE: Planview DXF assumes that Maximum Blowout occurs midspan. If Constructions are used (see section 15), then the construction is assumed to be orientated normal to the conductors.

9.21 Saving a Study

You are provided with an opportunity to enter the name or number of the project/profile study prior to nominating the folder and file name to be saved. The default file name is the project name, and the extension is type *.pnw*.

All 'Conductor', 'Material', 'Construction' and 'Structure' data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that the sag calculations etc will give the same results anywhere the study is opened.

The AutoSave function is available through the *Options* and also allows the user to set the save interval, this saves a copy of the study to *Temp directory/PNW Profile 'Date and Time Profiler was opened' .pnw*.
If for any reason a study is lost than it may be retrievable from the last save spot.

9.22 Clearing the Screen (New Profile)

Click on the *Clear* button to delete all survey data, poles and circuits.

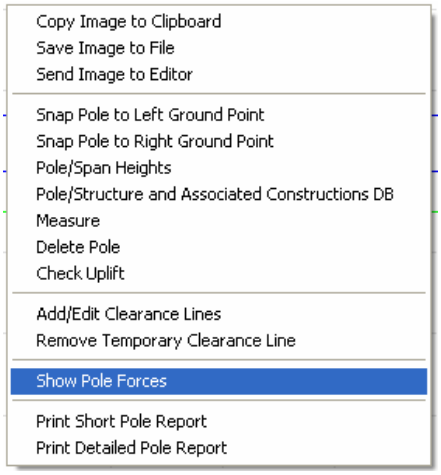
9.23 Opening a Study File

Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

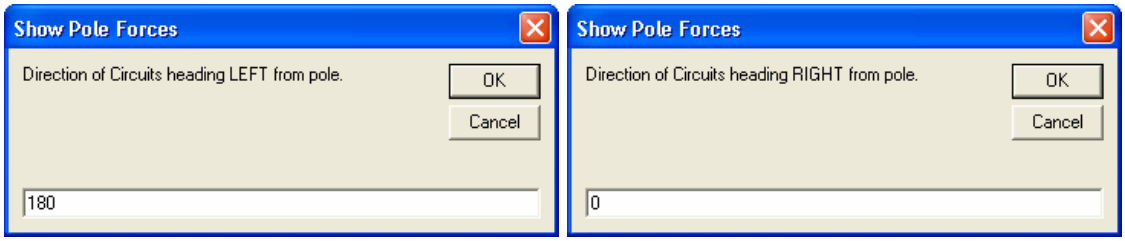
If Conductor/Material/Construction/Structure data in the save file is different to that on the host machine, then the user will be shown the two sets of data and will be asked which set of parameters they wish to adopt for that study. Changes are temporary and will be lost upon exiting of the program

9.24 Link to Pole Tip Load Calculator

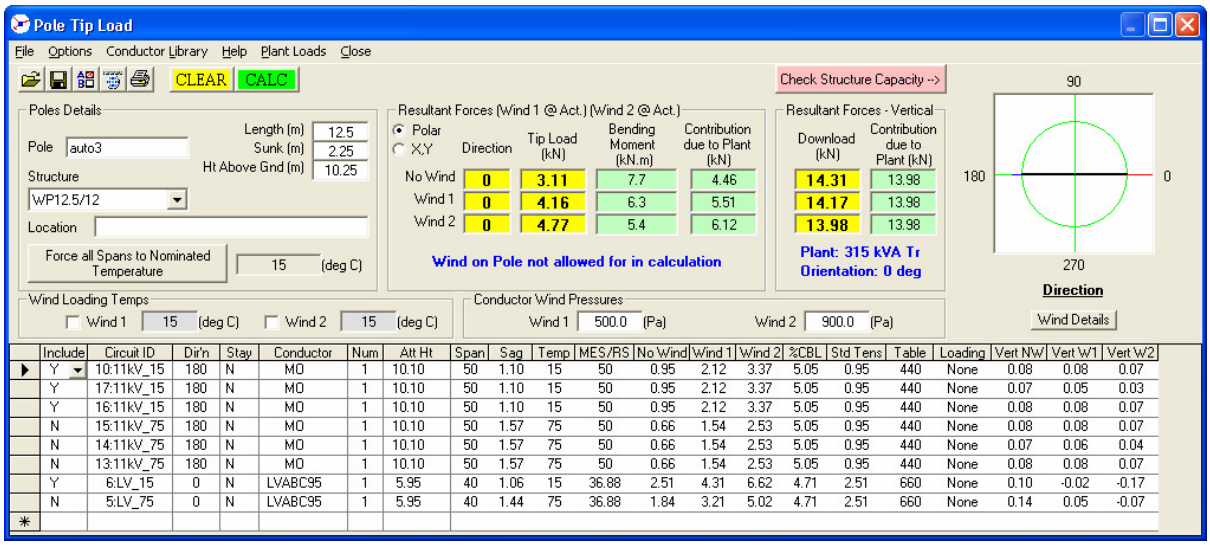
When the cursor is placed over a pole and the right mouse button clicked, the user may select the option *Show Pole Forces*. This is a link to the tip load calculator.



Pole/Structure details are passed on to the tip load calculator. Next you are asked to enter the *Directions* of circuits heading 'left' and 'right' from the nominated pole/structure (these values are added to the *Dir'n* column).



Poles 'n' wires sets the *Include* column in the circuits table to 'Y' only for circuits at the standard temperature. Circuits at other temperatures are not normally included in the forces calculation. (Some authorities use different temperatures when calculating 'No Wind', 'Wind 1' and 'Wind 2' condition loads.)



Include	Circuit ID	Dir'n	Stay	Conductor	Num	Att Ht	Span	Sag	Temp	MES/RS	No Wind	Wind 1	Wind 2	%CBL	Std Tens	Table	Loading	Vert NW	Vert W1	Vert W2
Y	10:11kV_15	180	N	MO	1	10.10	50	1.10	15	50	0.95	2.12	3.37	5.05	0.95	440	None	0.08	0.08	0.07
Y	17:11kV_15	180	N	MO	1	10.10	50	1.10	15	50	0.95	2.12	3.37	5.05	0.95	440	None	0.07	0.05	0.03
Y	16:11kV_15	180	N	MO	1	10.10	50	1.10	15	50	0.95	2.12	3.37	5.05	0.95	440	None	0.08	0.08	0.07
N	15:11kV_75	180	N	MO	1	10.10	50	1.57	75	50	0.66	1.54	2.53	5.05	0.95	440	None	0.08	0.08	0.07
N	14:11kV_75	180	N	MO	1	10.10	50	1.57	75	50	0.66	1.54	2.53	5.05	0.95	440	None	0.07	0.06	0.04
N	13:11kV_75	180	N	MO	1	10.10	50	1.57	75	50	0.66	1.54	2.53	5.05	0.95	440	None	0.08	0.08	0.07
Y	6:LV_15	0	N	LVABC95	1	5.95	40	1.06	15	36.88	2.51	4.31	6.62	4.71	2.51	660	None	0.10	-0.02	-0.17
N	5:LV_75	0	N	LVABC95	1	5.95	40	1.44	75	36.88	1.84	3.21	5.02	4.71	2.51	660	None	0.14	0.05	-0.07

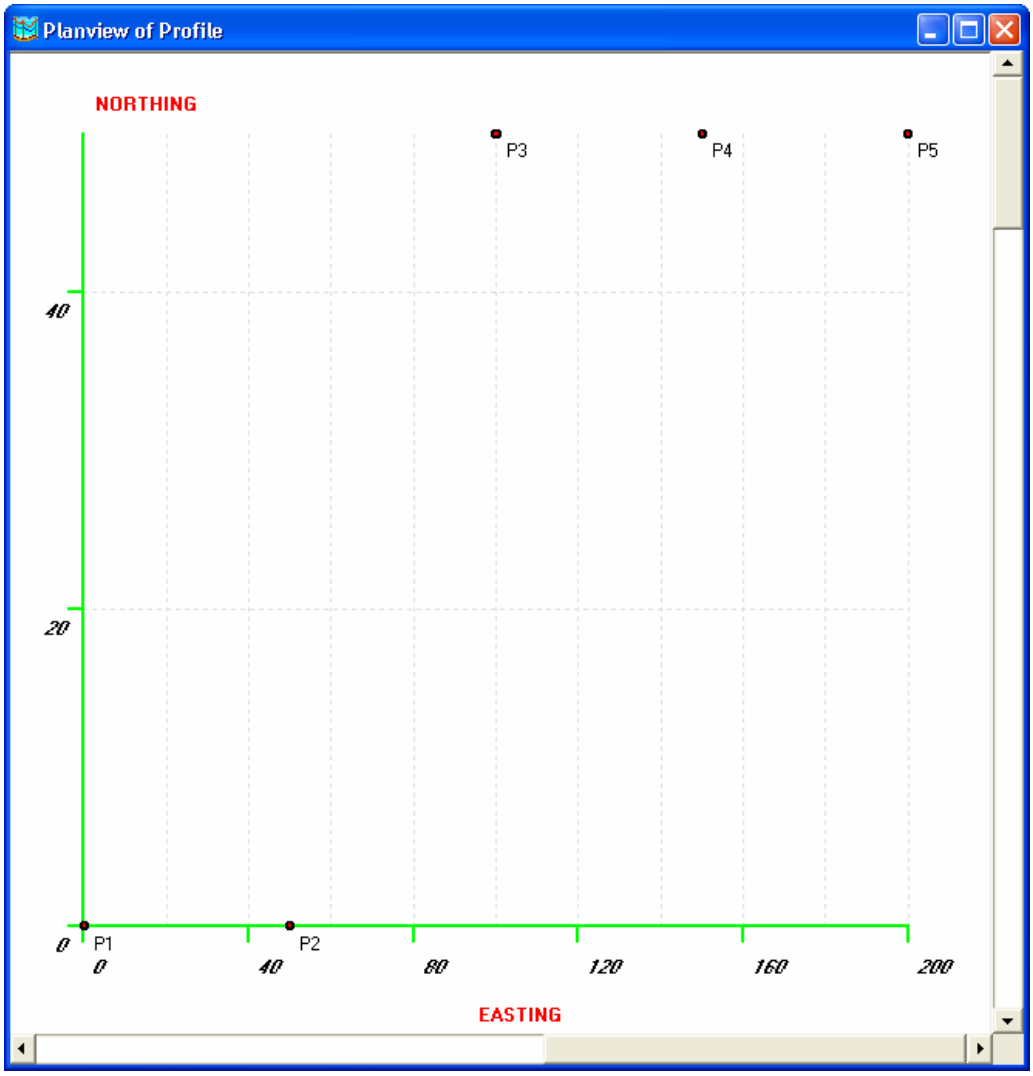
The *Pole-Mounted Plant* is also transferred across and added to the *Tip Load* (refer section 7).

The user may also need to check that the number of conductors is correct. (This column defaults to the value set in *Options* (refer section 4.4).) For *Constructions* a separate line is used for each conductor (allowing for difference in attachment heights on the construction itself).

Click on *Calculate* to determine the tip load or bending moment on the pole.

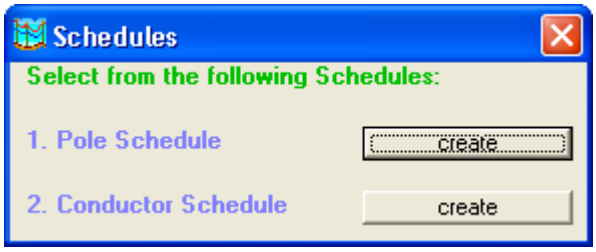
9.25 Planview

If the Poles/Structures are entered via the *Importing Ground Line/Profile Pole Data* (see 9.2), then the Easting and Northing of each pole/structure was also imported. Clicking on *Planview* displays a birds eye (planview) of the Profile's poles/structures.



Sliding the mouse over each pole/structure reveals it's details.

9.26 Schedules



Clicking on Schedules allows the user to generate Pole and Conductor schedules ascertaining to the Profile. They produce the following:

Pole Schedule

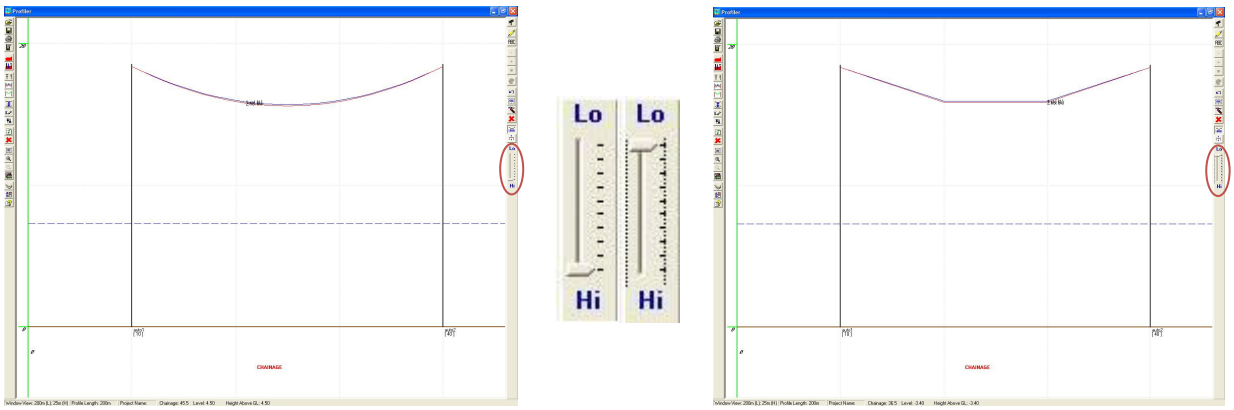
	A	B	C	D	E	F	G	H	I	J	K
1	Pole Schedule for "new profiler demo"										
2											
3	Pole#	Structure	Chainage (m)	Pole Length (m)	Sinking Depth (m)	Pole Height AG (m)	Plant	Construction	Attach Ht (m)	Distance From Tip (m)	Remarks
4	auto1	WP12.5/8	0	12.5	2.05	10.45	None	11S	10.30	0.15	
5	auto2	WP12.5/8	50	12.5	2.05	10.45	None	11TD	10.30	0.15	
6	auto3	WP12.5/8	100	12.5	2.05	10.45	None	11TD	10.30	0.15	
7	auto4	WP12.5/8	150	12.5	2.05	10.45	None	11TD	10.30	0.15	
8	auto5	WP14/12	200	14	2.3	11.7	315 kVA Tr	11T	11.55	0.15	
9								LVABC/T	7.40	4.30	
10	auto6	WP11/8	240	11	2	9	None	LVABC/SU3	8.70	0.30	
11	auto7	WP11/8	280	11	2	9	None	LVABC/T	8.70	0.30	
12											
13	Created by Poles 'n' Wires (c) PowerMation on 4/06/2007. Serial No. xxxxxx										

Conductor Schedule

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Conductor Schedule for "new profiler demo"														
2															
3	From Pole#	To Pole#	Strain Section	No. Wires	Conductor Type	No. Spans	Dist (m)	MES	%CBL	Stringing Tension	Stringing Table	Sag Span	Span Length (m)	Temp. (degrees C)	Sag (m)
4	auto1	auto5	A	3	MOON	4	200	50	5.05	0.95	440	auto1 - auto2	50.00	15.00	1.10
5														75.00	1.57
6												auto2 - auto3	50.00	15.00	1.10
7														75.00	1.57
8												auto3 - auto4	50.00	15.00	1.10
9														75.00	1.57
10												auto4 - auto5	50.00	15.00	1.10
11														75.00	1.57
12															
13	auto5	auto7	B	1	LVABC95 4C	2	80	40	4.71	2.51	660	auto5 - auto6	40.00	15.00	1.06
14														75.00	1.39
15												auto6 - auto7	40.00	15.00	1.06
16														75.00	1.39
17															
18	Created by Poles 'n' Wires (c) PowerMation on 4/06/2007. Serial No. xxxxxx														

9.27 Resolution Setting

There is a slider in the right tool bar which allows the user to change the resolution setting of the *Profile*. The lower the resolution the faster the *Profile* refreshes, however the accuracy of the display drops.

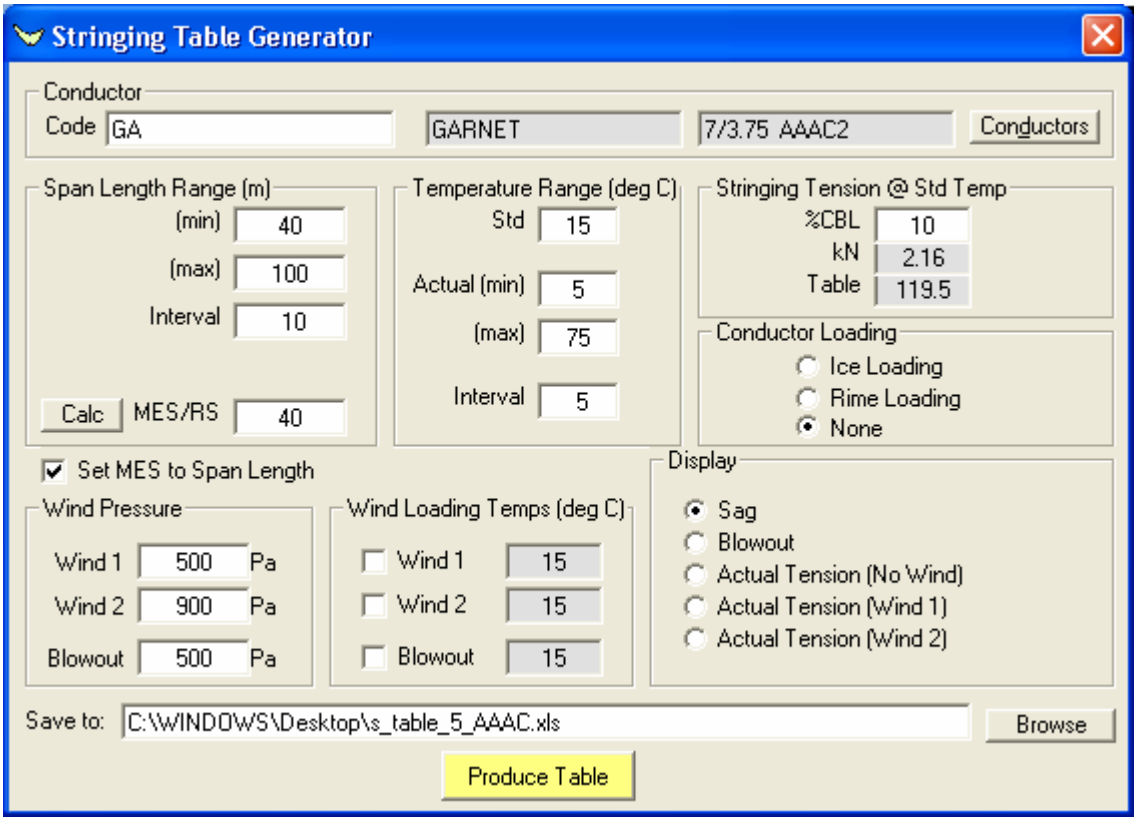


The resolution setting does not affect any functions, it only adjusts the display.

Lower resolution settings are particularly useful when large profiles are used with multiple circuits, this feature will dramatically increase refresh times.

NOTE: Although generous limits apply to entities (refer section 4.10), the time taken to redraw the profile increases with every addition, thus a trade-off between the size of profiles and the time taken to redraw the profile is needed. Take care not to generate unnecessary circuits and keep profile lengths reasonable (split into several profiles if needed).

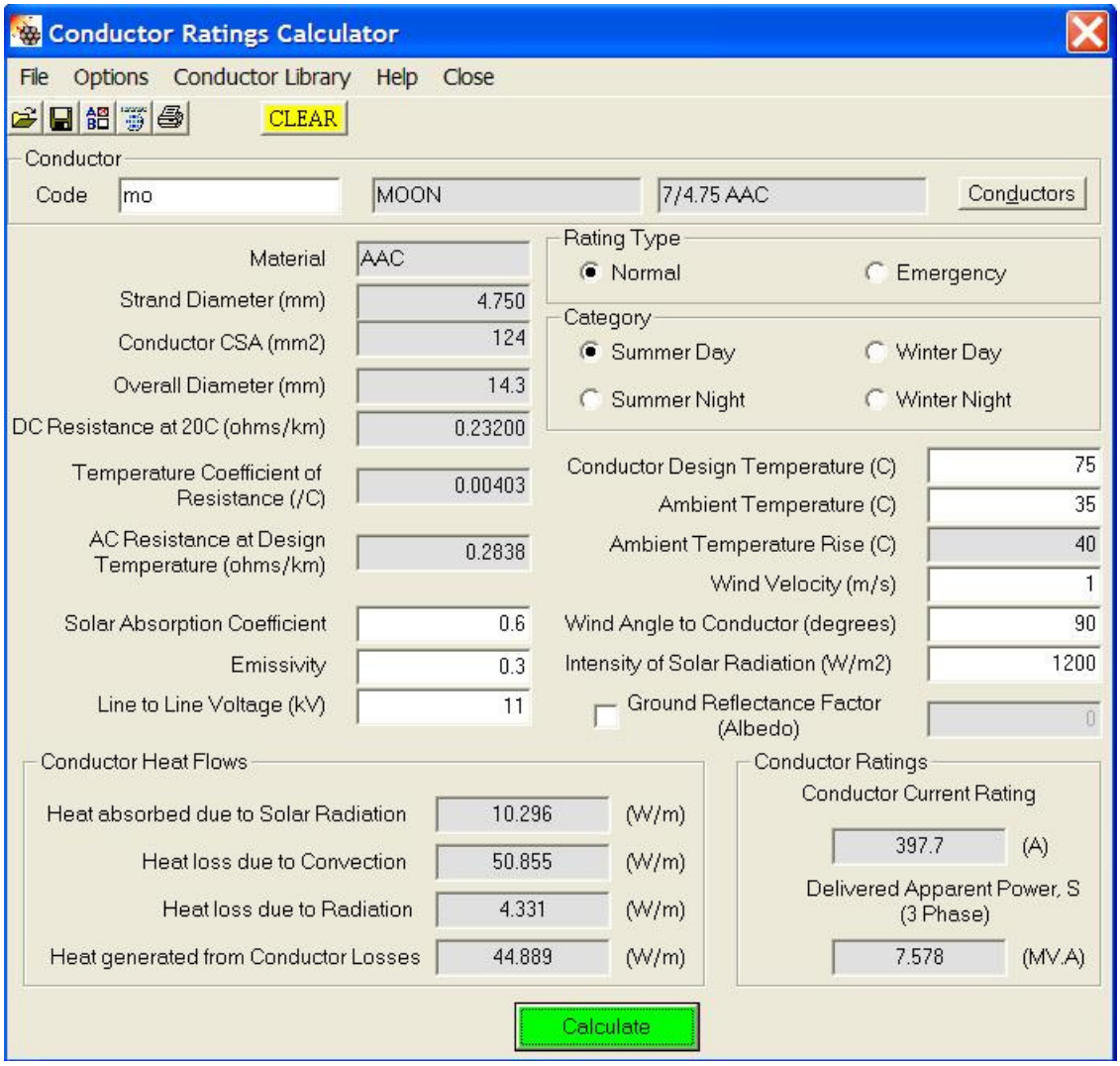
10. STRINGING TABLE GENERATOR



The stringing table generator is similar in operation to the Sag-Tension-Temperature module described in section 6. However, rather than calculate results for a single condition, results are generated for a range of temperatures and span lengths. These results are stored as a Microsoft *Excel* spreadsheet.

An example of use of this module is provided in section 3.4.

11. CONDUCTOR RATINGS CALCULATOR



11.1 Conductor Selection

When the user enters a valid unique conductor code, the program will display the physical and electrical parameters of the conductor. If uncertain of the conductor code to enter, click on the *Conductors* button to activate the window shown below.

Now either:

(i) enter a partial match to the code into the *Find Code* input box, or

(ii) select the conductor material from the drop-down list and check the box to indicate whether the conductor is insulated or bare. (Note: If searching for an ACSR conductor, you should look through conductors in categories 'ACSR' and 'ACSR2', which have different aluminium/steel ratios, as well as 'AACSR', aluminium alloy with steel. Similarly, two types of AAAC have been allowed for, depending upon the class of alloy.)

The conductor grid will display all conductors within the database that match your search criteria. Click on the line for the desired conductor.

Click on the Conductor Library icon if you find it necessary to add or edit the available conductors.

Once a conductor has been selected, the physical and electrical parameters of the conductor are displayed.

11.2 Solar Absorption Coefficient

The standard solar absorption coefficient should already be set, according to the default value in the *Options* (refer section 4.8).

The solar absorption is a measure of the incident solar radiation the conductor surface can absorb, ranging in value from 0 (reflective surface) to 1 (perfectly absorbent surface). As a guide, the solar absorption coefficient is 0.6 for new bright conductors and 0.9 for old or blackened conductors. Values in the range 0.8 - 0.85 are typical for in-service conductors.

11.3 Emissivity

The standard emissivity should already be set, according to the default value in the *Options* (refer section 4.8).

The emissivity of a conductor is a measure of the efficiency with which the surface radiates heat, ranging from 0 to 1. As a guide, the emissivity is 0.3 for new bright conductors and 0.9 for old or blackened conductors. Values in the range 0.6 - 0.85 are typical for in-service conductors.

11.4 Line to Line Voltage

The default value as set in *Options* (refer section 4.8), may be amended by the user within the module. This value is used to convert the current rating into a MV.A rating.

11.5 Selection of Rating Type/Category

The preferred rating type and category should already be set, according to the default values in the *Options* (refer section 4.8). To change the rating type, click the radio button on, either 'Normal' or 'Emergency' condition. This will set the wind velocity and maximum conductor temperature accordingly.

To change the category type, click the radio button on the desired category 'Summer Day', 'Winter Day', 'Summer Night' or 'Winter Night'. This will set the solar radiation and ambient temperature accordingly. For night-time ratings set the incident solar radiation to nil.

11.6 Conductor Design Temperature

The conductor design temperature should already be set, according to the chosen rating type. To change the default conductor design temperature, refer to *Options* (section 4.8).

You many wish to amend the temperature to suit the particular conductor. The current rating improves dramatically with increasing temperature. However, the temperature should not be so high that:

- there is partial annealing or loss of tensile strength
- the line sags excessively and clearances are not maintained.

Values of 75°C are typical for normal ratings. However, higher values may be used for short-term emergency ratings and for new high temperature conductors. Older lines were often designed to operate at 50°C.

11.7 Ambient Temperature

The ambient air temperature should already be set, according to the chosen category. To change the default ambient temperature for a category, refer to *Options* (section 4.8). The user may modify the ambient temperature value to suit. The ambient temperature rise is calculated; it is the difference between the conductor design temperature and ambient temperature.

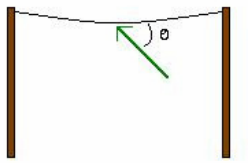
11.8 Wind Velocity

The wind velocity should already be set, according to the chosen rating type. To change the default wind velocity for a rating type selection, refer *Options* (section 4.8). The user may modify the wind velocity to suit the local weather conditions. Increasing wind velocity affects conductor ratings significantly.

11.9 Wind Angle to Conductor

The standard wind angle to conductor should already be set, according to the default value in *Options* (refer section 4.8).

The wind angle to conductor refers to the incident angle of the wind to the conductor, ranging from 0 to 90 degrees. An incident angle of 0° means that the wind angle is parallel to the line. An incident angle of 90° means that the wind is normal to the line.



11.10 Intensity of Solar Radiation

The intensity of solar radiation should already be set, according to the chosen category. To change the default values, refer *Options* (refer section 4.8). Values of 1000 W/m^2 are typical, but this will vary with latitude and season.

11.11 Ground Reflectance Factor (Albedo)

The standard ground reflectance factor (albedo) should already be set, according to the default value in *Options* (refer section 4.8).

The ground reflectance factor is the ratio of reflected solar radiation to direct incident radiation. This factor is low for foliage and high for bright reflective surfaces, e.g. pavement or salt flat. The user should amend to suit the conditions for the line.

Uncheck Albedo to ignore the effects of Albedo in the Rating Calculation.

11.12 Results

To calculate the conductor rating, either press the 'Enter' button on the keyboard once all fields have been entered or click the 'Calculate' button on the screen. Any errors in the inputs fields will be highlighted in red and a message box will pop up describing the error. If all input fields are valid then the results will be presented.

The program calculates the current rating in amperes (A), and delivered three-phase apparent power in megavolt-amperes (MV.A), of the conductor for the specified conditions. It also displays the following intermediate results:

<u>Heat absorbed due to solar radiation</u> represents the thermal input per unit length by solar irradiation in Watts per metre (W/m).

<u>Heat generated from conductor losses</u> represents the thermal input per unit length due to 'I^2R' losses in the conductor in Watts per metre (W/m).

<u>Heat loss due to convection</u> represents the thermal output per unit length by convection in Watts per metre (W/m).

<u>Heat loss due to radiation</u> represents the thermal output per unit length by solar radiation in Watts per metre (W/m).

11.13 Printing a Report

Either click on the printer icon or alternatively under the file menu drop down list select 'print' to print a report of the results.

11.14 Saving a Study

Either click on the disk icon or alternatively under the file menu drop down list select 'Save' to save a conductor ratings study. Enter a project/study name when prompted to do so (if the project name hasn't already been entered) and click 'Ok'. The save file dialog box will appear, in which the filename of the study is to be entered (defaults to project/study name, plus extension *.pnw*). You may nominate the folder in which the file is stored.

All 'Conductor' and 'Material' data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that the calculations will give the same results anywhere the study is opened.

11.15 Clearing the Screen

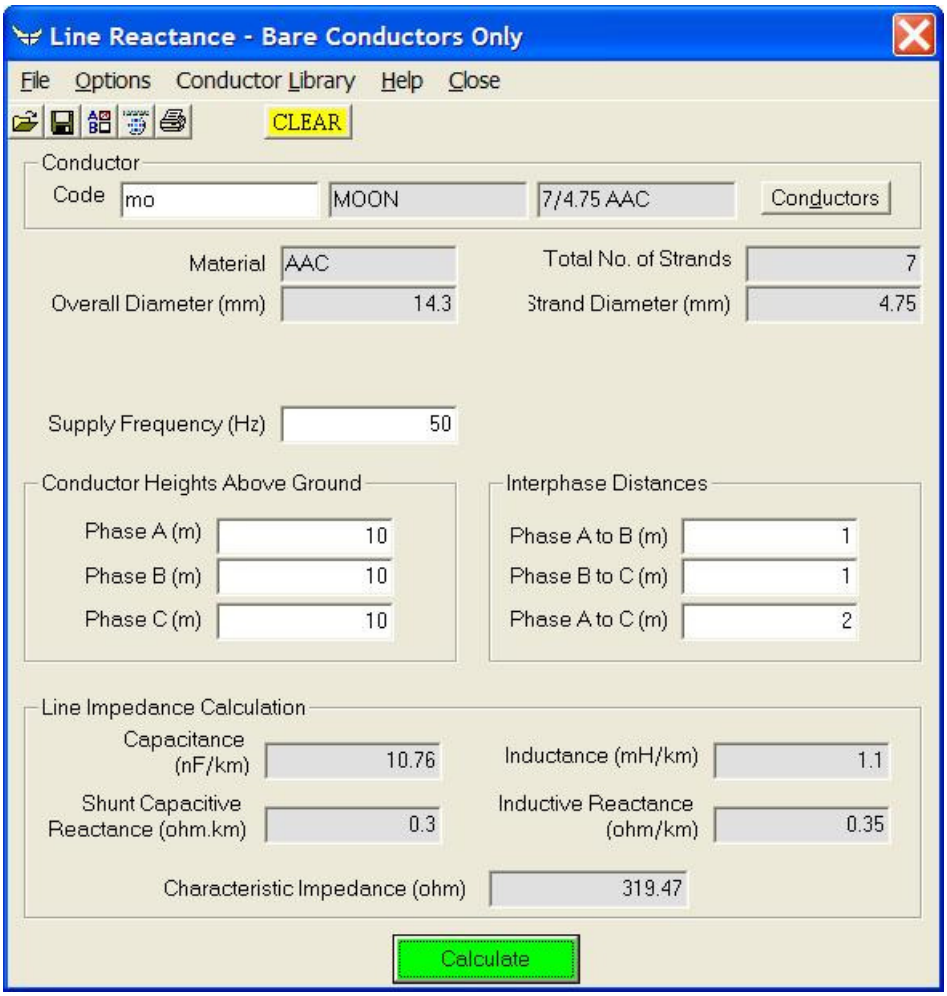
Click on *Clear* to remove all details of the conductor and load the default parameters.

11.16 Opening a Study File

Either click on the open icon or alternatively under the file menu drop down list select 'Open' to open an existing conductor ratings study file. Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

If Conductor/Material data in the save file is different to that on the host machine, then the user will be shown the two sets of data and will be asked which set of parameters they wish to adopt for that study. Changes are temporary and will be lost upon exiting of the program.

12. LINE REACTANCE CALCULATOR



Note: The Line Reactance calculator is for bare conductors only.

12.1 Conductor Selection

When the user enters a valid unique conductor code, the program will display the conductor names. If uncertain of the conductor code to enter, click on the *Conductors* button to activate the window shown below.

Now either:

(i) enter a partial match to the code into the *Find Code* input box, or

(ii) select the conductor material from the drop-down list and check the box to indicate whether the conductor is insulated or bare. (Note: If searching for an ACSR conductor, you should look through conductors in categories 'ACSR' and 'ACSR2', which have different aluminium/steel ratios, as well as 'AACSR', aluminium alloy with steel. Similarly, two types of AAAC have been allowed for, depending upon the class of alloy.)

The conductor grid will display all conductors within the database that match your search criteria. Click on the line for the desired conductor.

Click on the Conductor Library icon if you find it necessary to add or edit the available conductors.

Once a conductor has been selected, the physical and electrical parameters of the conductor are displayed.

12.2 Supply Frequency

The standard supply frequency should already be set, according to the default value in *Options* (refer section 4.8). However the user may alter this value within the application to suit.

12.3 Correction Factor

A correction factor may be entered to account for the effect of the steel core in conductors such as ACSR. Otherwise this value defaults to zero.

The program calculates inductance according to the following formula:

$$L = 0.2\log_e\left(\frac{GMD}{GMR} + k\right)$$

where:

L is the inductance of the line (mH/km)
GMD is the geometric mean distance between conductors (m)
GMR is the geometric mean radius of conductor (m)
k is a correction factor.

12.4 Conductor Heights

The average height above ground for each phase of the line is approximately equal to the conductor attachment height at the supports less two-thirds of the maximum midspan sag.

12.5 Interphase Distances

Enter in the distances between phases in metres.

12.6 Results

To calculate the line reactance, either press the 'Enter' button on the keyboard once all fields have been entered or click the 'Calculate' button on the screen. Any errors in the input fields will be highlighted in red and a message box will pop up describing the error. If all input fields are valid then the results will be calculated and displayed on screen.

The program calculates the following electrical line parameters:
Line capacitance in nanofarads per kilometre (nF/km).

Shunt line capacitive reactance in ohm kilometres (Ω.km).

Line inductance in milllihenrys per kilometre (mH/km).

Line inductive reactance per kilometre in ohms per kilometre (Ω/km).

Characteristic Impedance of the line in ohms.

12.7 Printing a Report

Either click on the printer icon or alternatively under the file menu drop down list select ‘print’ to print a report of the results.

12.8 Saving a Study

Either click on the disk icon or alternatively under the file menu drop down list select ‘Save’ to save a line reactance study. Enter a project/study name when prompted to do so (if the project name hasn’t already been entered) and click ‘Ok’. The save file dialog box will appear, in which the filename of the study is to be entered (defaults to project/study name, plus extension *.pnw*). You may nominate the folder in which the file is stored.

All ‘Conductor’ and ‘Material’ data is now saved with study files, this allows users to send files between different computers and still have the same parameters. This means that the calculations will give the same results anywhere the study is opened.

12.9 Clearing the Screen

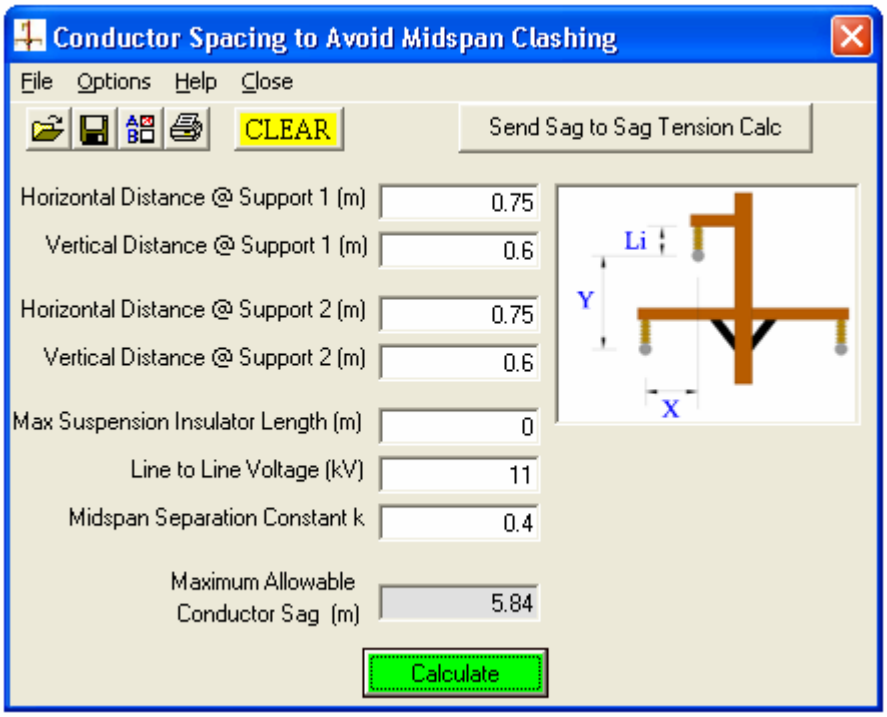
Click on *Clear* to remove all details of the conductor and line configuration and load the default frequency.

12.10 Opening a Study File

Either click on the open icon or alternatively under the file menu drop down list select ‘Open’ to open an existing conductor ratings study file. Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

If Conductor/Material data in the save file is different to that on the host machine, then the user will be shown the two sets of data and will be asked which set of parameters they wish to adopt for that study. Changes are temporary and will be lost upon exiting of the program.

13. CONDUCTOR SPACING CALCULATOR



This module is used when:

- designing structures, to ensure that there is adequate spacing between phases to prevent mid-span clashing, or
- to determine the maximum span length for a given structure and stringing tension.

It should be used in conjunction with the *Sag Tension Temperature* module.

13.1 Phase Spacing

Enter horizontal and vertical distances between conductors in metres at both Supports. Note that the vertical spacing provides more effective separation than horizontal spacing.

13.2 Suspension Insulator Length

This is the free-swinging length of a suspension insulator from pivot point to conductor. For pin, post or strain insulators, which hold the conductor rigidly in place, enter zero.

13.3 Line to Line Voltage

A value will be pre-loaded from *Options* (section 4.8). However the user should amend this to suit the particular line.

13.4 Midspan Separation Constant

The program uses the following formula:

$$\sqrt{X^2 + (1.2Y)^2} \geq \frac{U}{150} + k\sqrt{D + l_i}$$

where:

X is the horizontal distance between conductors (m)
where $X = (X_1 + X_2)/2$

Y is the vertical distance between conductors (m)
where $Y = (Y_1 + Y_2)/2$

U is the line to line voltage (kV)

k is a constant, normally equal to 0.4

D is the conductor sag in the span (m)

Li is the length of any suspension insulator (m)

The value for k is loaded from *Options* (refer section 4.8), however the user may amend the value of k to suit. Increasing k will decrease the maximum allowable sag for a given spacing.

13.5 Result – Maximum Allowable Sag

To calculate the maximum allowable conductor sag, either press the 'Enter' button on the keyboard once all fields have been entered or click the 'Calculate' button on the screen. Any errors in the inputs fields will be highlighted in red and a message box will pop up describing the error. If all input fields are valid then the result will be displayed.

13.6 Printing a Report

Either click on the printer icon or alternatively under the file menu drop down list select 'Print' to print a report of the results.

13.7 Saving a Study

Either click on the disk icon or alternatively under the file menu drop down list select 'Save' to save a conductor spacing study. Enter a project/study name when prompted to do so (if the project name hasn't already been entered) and click 'Ok'. The save file dialog box will appear, in which the filename of the study is to be entered (defaults to project/study name, plus extension *.pnw*). You may nominate the folder in which the file is stored.

13.8 Clearing the Screen

Click on *Clear* to remove all line details and load the default line to line voltage, midspan separation constant and set the free swing insulator length to the default value of zero.

13.9 Opening a Study File

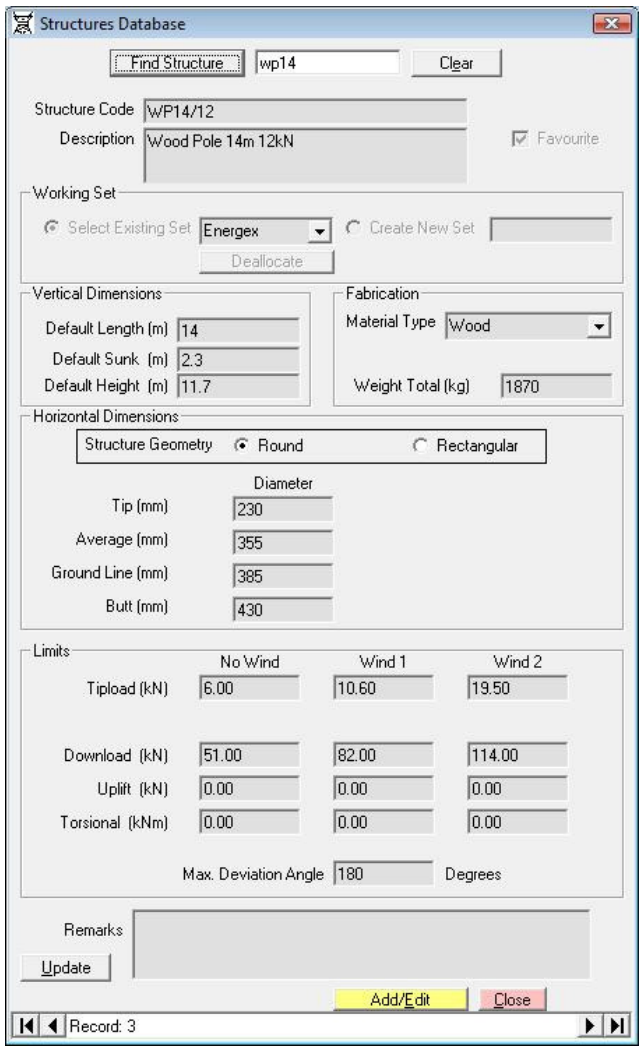
Either click on the open icon or alternatively under the file menu drop down list select 'Open' to open an existing conductor spacing study file. Browse through the relevant folder or directory, until the desired file (with extension *.pnw*) is located. Click on the file to highlight it and then click the *Open* button.

13.10 Send Sag to Sag Tension Calculator

Click on the *Send Sag to Sag Tension Calc* to send the *Maximum Allowable Conductor Sag* to the *Sag Tension* module (refer section 6). The maximum allowable stringing table can then be calculated.

14. STRUCTURES DATABASE

14.1 Finding a Pole/Structure within the Database



You may step forwards or backwards through the database one structure record at a time using the forward and backward arrow keys in the data control at the base of the screen. The outer arrows enable you to move to the first or last structures within the database.

Alternatively you may enter the code of the structure you are searching for in the input box and click on the *Find Next* button to go to a particular structure with a code name matching that typed within the input box. For example, if we type “WP14” in the input box and then *Find Next*, the database record for “WP14/12” will be displayed. Clicking on *Find Next* again, we then move to records for “WP14/20” AND “WP14/8”..

14.2 Structure Parameters

Code A short, unique identifier for the pole/structure, eg 'WP12.5/12'. (MANDATORY)
Description The short description relating to the structure, eg 'Wood Pole 12.5m 12kN'

Working Set The set that the structure is a member of, eg 'SET 1'. Select an existing set from the dropdown menu, create a new set or click on deallocate to remove an existing structure from a set. (OPTIONAL)

Vertical Dimensions (MANDATORY)

- Default Length The default total length of the structure
- Default Sunk The default sinking depth or embedment of the structure
- Default Height The default height above ground of the structure

Fabrication (OPTIONAL)

- Material Type The material type that the structure is composed of, 'Composite ', 'Concrete', 'Steel', 'Wood' or 'Other'
- Description A description of the material type (only if material type is set to 'Other')
- Weight Total The total weight of the structure

Horizontal Dimensions (OPTIONAL)

- Round (Diameter) or Rectangular section type (Face and Side Widths)
- Tip The diameter or width at the tip of the structure
- Average The average diameter or width of the structure
- Ground Line The diameter or width at the ground line of the structure
- Butt The diameter or width at the butt of the structure

Limits (OPTIONAL)
(Limits of the structure under No Wind, Wind 1 and Wind 2 conditions)

- Tipload 1 The strength of the structure in any direction (for round poles), or in the direction of the 'face' of a rectangular section structure.
- Tipload 2 (The strength of the structure in the direction of the 'side' of a rectangular section structure. (This field is not available for round poles.)
- Download The download limit of the structure
- Uplift The uplift limit of the structure
- Torsional The torsional limit of the structure

- Max Deviation Angle The maximum deviation angle that the construction can be subjected to.

Note: The limits Uplift, Torsional Strength and Max. Deviation Angle are for information only—there are no checks performed to see that whether these are exceeded.

Remarks Any additional comments or directives relating to the structure. (OPTIONAL)

Favourite Enter 'Y' if the structure is one that you will use frequently; otherwise enter 'N'. Favourites are listed before others in structure lists. (MANDATORY)

NOTE: The structures provided with Poles 'n' Wires are by way of example only. Users should review the properties of structures that they will use in any studies and ensure that the parameters listed in the database are consistent with the structures being purchased for the project.

14.3 Editing Structure Parameters

Scroll through the list of structures until you locate the record you wish to edit. You may alter any of the parameters listed for the structure. Click on the *Edit* button and modify the data as required. To leave Edit mode, click on *Read Only*.

14.4 Deleting a Structure

Scroll through the list of structures until you locate the record you wish to delete. Click on the *Edit* button, then the *Delete* button to delete the structure currently being displayed from the database. To leave Edit mode, click on *Read Only*.

14.5 Adding a Structure

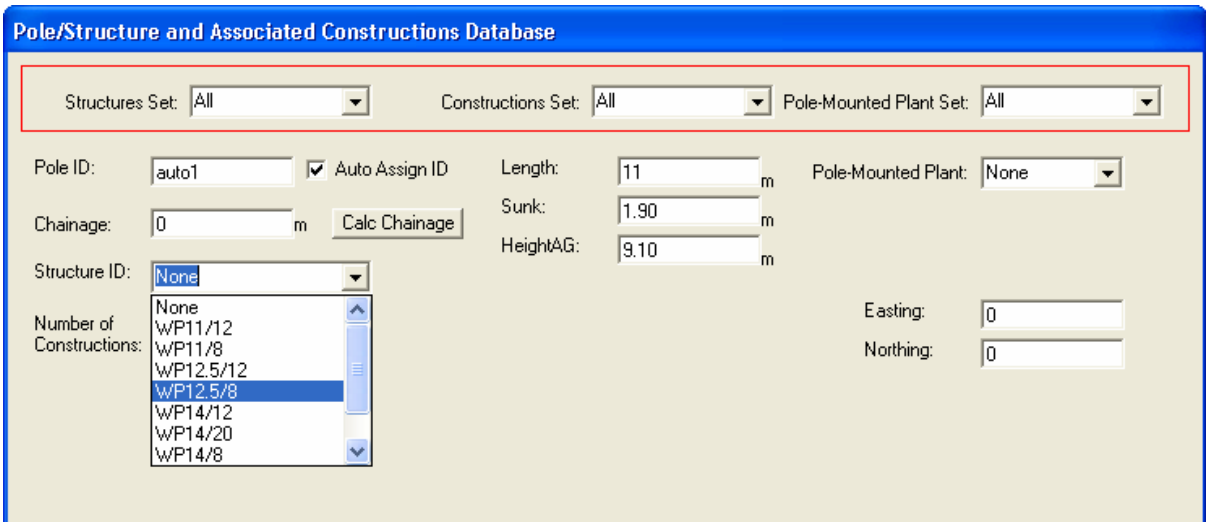
Click on the *Edit* button, then the *Add* button to add a new structure. A blank template will appear.

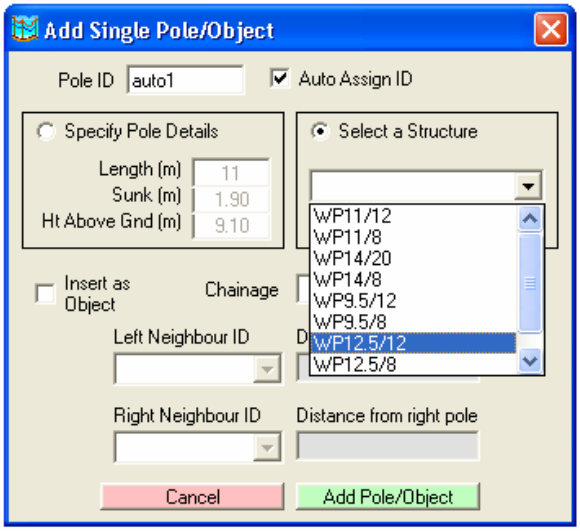
Enter the various parameters, as described above, starting with a unique identifying code for the structure. Some fields are mandatory, as indicated above; others are optional. Click on *Update* to save the new structure. When entering a new structure, it is recommended that you have all the necessary structure data from the manufacturer, relevant standard or power authority on hand.

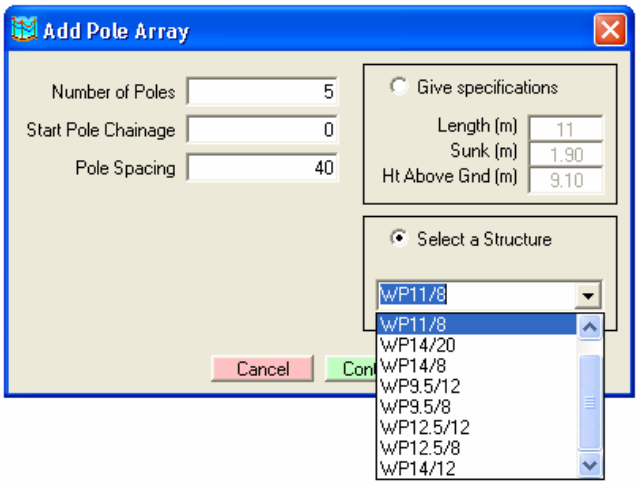
To leave Edit mode, click on *Read Only*.

14.6 Including Structures in Designs

Structures may be selected for use from within the *Line Profiler* Module. The structures may be chosen from within the *Pole/Structure and Associated Constructions Database*, *Add Single Pole* and *Add Pole Array* forms, as shown below. Structures may also be selected for use in the *Tip Loads* module.

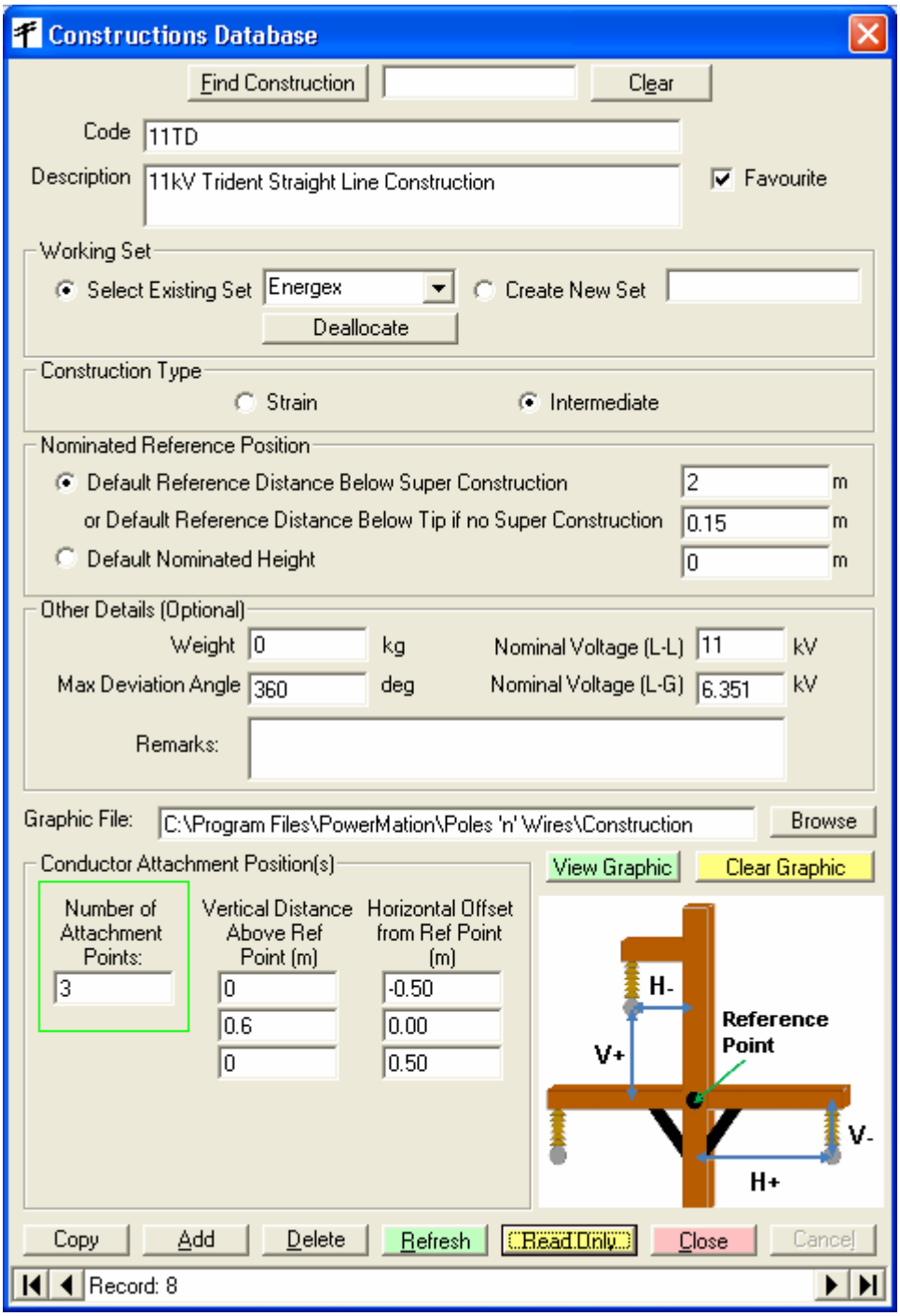






15. CONSTRUCTIONS DATABASE

15.1 Finding a Construction within the Database



You may step forwards or backwards through the database one construction record at a time using the forward and backward arrow keys in the data control at the base of the screen. The outer arrows enable you to move to the first or last constructions within the database.

Alternatively you may enter the code of the construction you are searching for in the input box and click on the *Find Next* button to go to a particular construction with a code name matching that typed within the input box. For example, if we type "LV" in the input box and then *Find Next*, the database record for "LVA" will be displayed. Clicking on *Find Next* again, we then move to records for "LVABC/A", "LVABC/SU3", "LVABC/SU4", and "LVU".

15.2 Construction Parameters

Code A short, unique identifier for the construction, eg '11TD'. (MANDATORY)
Description The short description relating to the construction, eg '11kV Trident Straight Line Construction'. (OPTIONAL)

Working Set The set that the construction is a member of, eg 'SET 1'. Select an existing set from the dropdown menu, create a new set or click on deallocate to remove an existing construction from a set. (OPTIONAL)

Construction Type Select Strain or Intermediate. (MANDATORY)
Nominated Reference Position This is the nominated position on the pole that the Construction will be attached at. Choose to enter a default reference position below super construction (or below tip if no super construction exists) or a default nominated height. (MANDATORY)

Other Details (OPTIONAL)

- Weight The total weight of the construction (eg all cross-arms, insulators, nuts, bolts, etc)
- Max Deviation Angle The maximum deviation angle that the construction can be subjected to
- Nominal Voltage (L-L) The line to line voltage rating of the construction
- Nominal Voltage (L-G) The line to ground voltage rating of the construction
- Remarks Any additional comments or directives relating to the construction

Conductor Attachment Position(s) (MANDATORY)

- Number of Attachment Points The number of conductor attachment points on the construction
- Vertical Distance Above Ref Point The vertical distance above the nominated reference point, that the conductors are attached to the construction (negative values should be used to indicate conductor attachment points below the nominated reference point)

Horizontal Offset from Ref Point The horizontal offset from the nominated reference point, that the conductors are attached to the construction (negative values should be used to indicate conductor attachment points to the left of the nominated reference point looking at it front on and positive values to the right).

Graphic Select a graphic file to represent the construction. (OPTIONAL)

Favourite Enter 'Y' if the construction is one that you will use frequently; otherwise enter 'N'. Favourites are listed before others in construction lists. (MANDATORY)

NOTE: Users should review the properties of constructions that they will use in any studies and ensure that the parameters listed in the database are consistent with the constructions being purchased for the project.

15.3 Editing Construction Parameters

Scroll through the list of constructions until you locate the record you wish to edit. You may alter any of the parameters listed for the construction. Click on the *Edit* button and modify the data as required. To leave Edit mode, click on *Read Only*.

15.4 Deleting a Construction

Scroll through the list of constructions until you locate the record you wish to delete. Click on the *Edit* button, then the *Delete* button to delete the construction currently being displayed from the database. To leave Edit mode, click on *Read Only*.

15.5 Adding a Construction

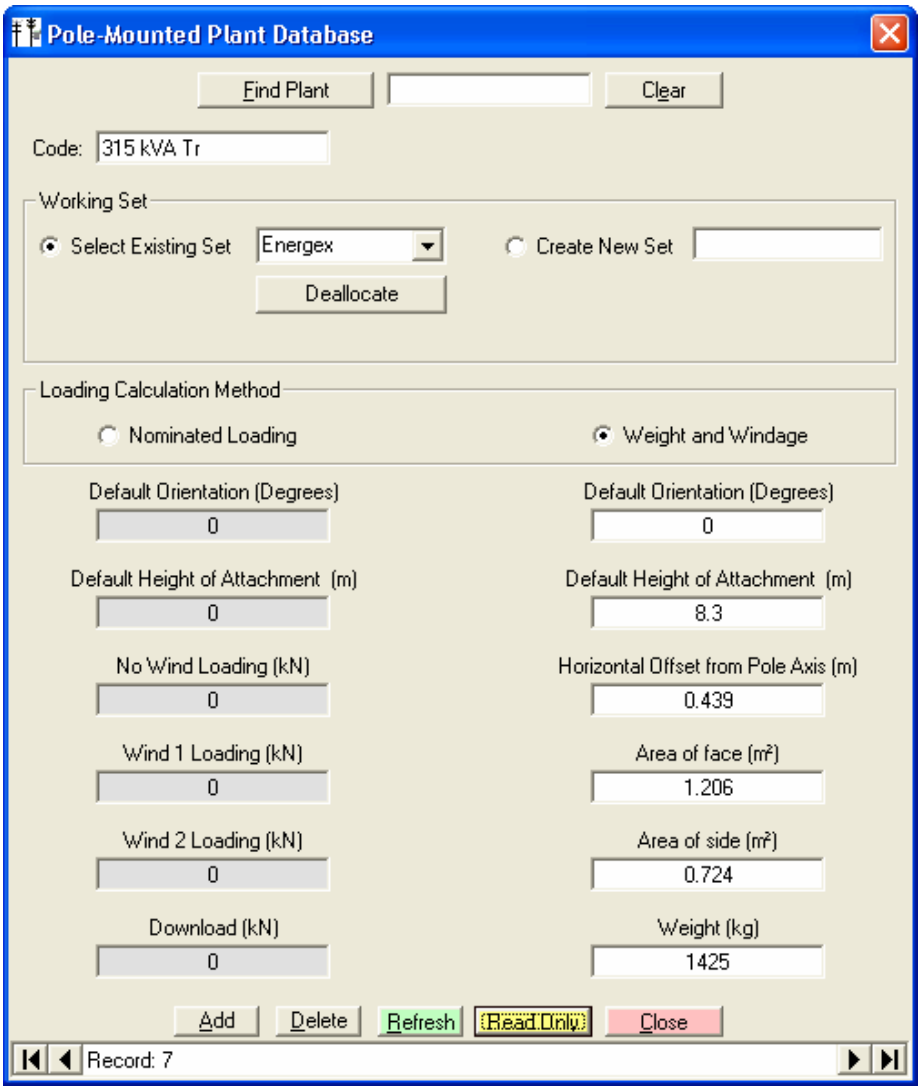
Click on the *Edit* button, then the *Add* button to add a new construction. A blank template will appear.

Enter the various parameters, as described above, including an identifying code for the construction. Some fields are mandatory, as indicated above; others are optional. Click on *Update* to save the new construction. When entering a new construction, it is recommended that you have all the necessary construction data from the manufacturer, relevant standard or power authority on hand.

To leave Edit mode, click on *Read Only*.

16. POLE-MOUNTED PLANT DATABASE

16.1 Finding a Plant Item within the Database



You may step forwards or backwards through the database one plant item record at a time using the forward and backward arrow keys in the data control at the base of the screen. The outer arrows enable you to move to the first or last plant items within the database.

Alternatively you may enter the code of the plant item you are searching for in the input box and click on the *Find Next* button to go to a particular plant item with a code name matching that typed within the input box. For example, if we type “10” in the input box and then *Find Next*, the database record for “100 kVA Tr” will be displayed. Clicking on *Find Next* again, we then move to records for “100A Regulator” AND “10 kVA Tr”.

16.2 Plant Item Parameters

Code A short, unique identifier for the plant item, eg '10 kVA Tr'. (MANDATORY)
Working Set The set that the plant item is a member of, eg 'SET 1'. Select an existing set from the dropdown menu, create a new set or click on deallocate to remove an existing plant item from a set. (OPTIONAL)

Loading Calculation Method Choose one of the 2 methods:

Nominated Loading – where the Wind 1 and Wind 2 loadings on the plant item are known and specified

Weight and Windage – where the weight, horizontal offset from pole axis and windage and the Area of the face and side of the plant item are known (MANDATORY)

Default Orientation The orientation (0-359°) of the plant item on the pole. (MANDATORY)
Default Height of Attachment The default height that the plant item is attached to the pole. (MANDATORY)

No Wind Loading The no wind loading of the plant item. (MANDATORY for Loading Calculation Method 'Nominated Loading')
Wind (1&2) Loadings The wind loadings of the plant item under Wind 1 and Wind 2 conditions. (MANDATORY for Loading Calculation Method 'Nominated Loading')
Download The download due to the plant item (eg Plant Mass * Gravity) (MANDATORY for Loading Calculation Method 'Nominated Loading')

Horizontal Offset from Pole Axis The horizontal offset of the plant item (centre of mass) from the pole's axis (pole centre line). (MANDATORY for Loading Calculation Method 'Weight & Windage')
Area of (face & side) The areas of the outward face and of the major side of the plant item. (MANDATORY for Loading Calculation Method 'Weight & Windage)
Weight The weight of the plant item. (MANDATORY for Loading Calculation Method 'Weight & Windage')

NOTE: Users should review the properties of plant items that they will use in any studies and ensure that the parameters listed in the database are consistent with the plant items being purchased for the project.

16.3 Editing Plant Item Parameters

Scroll through the list of plant items until you locate the record you wish to edit. You may alter any of the parameters listed for the plant item. Click on the *Edit* button and modify the data as required. To leave Edit mode, click on *Read Only*.

16.4 Deleting a Plant item

Scroll through the list of plant items until you locate the record you wish to delete. Click on the *Edit* button, then the *Delete* button to delete the plant item currently being displayed from the database. To leave Edit mode, click on *Read Only*.

16.5 Adding a Plant Item

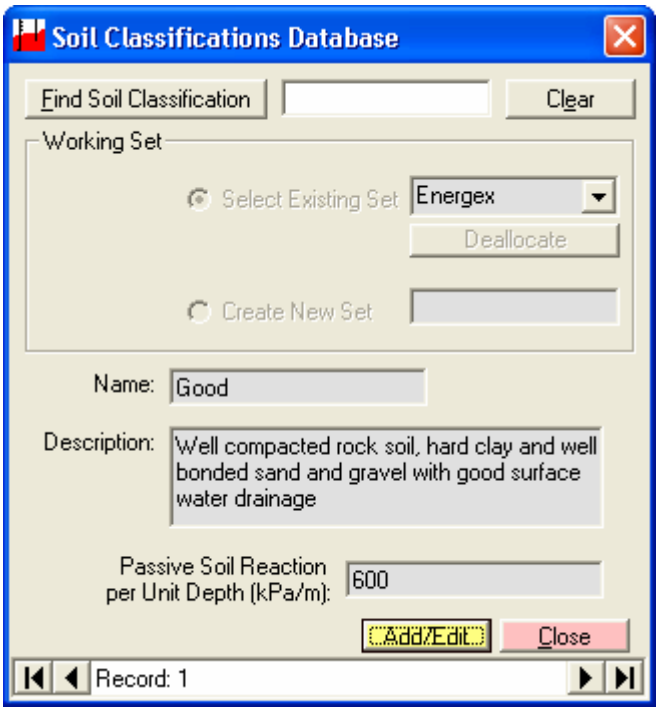
Click on the *Edit* button, then the *Add* button to add a new plant item. A blank template will appear.

Enter the various parameters, as described above, including an identifying code for the plant item. Some fields are mandatory, as indicated above; others are optional. Click on *Update* to save the new plant item. When entering a new plant item, it is recommended that you have all the necessary plant item data from the manufacturer, relevant standard or power authority on hand.

To leave Edit mode, click on *Read Only*.

17. SOIL CLASSIFICATIONS DATABASE

17.1 Finding a Soil Classification within the Database



This database is used in conjunction with the simple foundation strength calculator.

You may step forwards or backwards through the database one soil classification record at a time using the forward and backward arrow keys in the data control at the base of the screen. The outer arrows enable you to move to the first or last soil classifications within the database.

Alternatively you may enter the code of the soil classification you are searching for in the input box and click on the *Find Next* button to go to a particular soil classification with a code name matching that typed within the input box. For example, if we type "P" in the input box and then *Find Next*, the database record for "Poor" will be displayed.

17.2 Soil Classification Parameters

Working Set The set that the soil classification is a member of, eg 'SET 1'. Select an existing set from the dropdown menu, create a new set or click on deallocate to remove an existing soil classification from a set. (OPTIONAL)
Code A short, unique identifier for the soil classification, eg 'Good'. (MANDATORY)

Description The short description relating to the soil classification, eg 'Well compacted rock soil, hard clay and well bonded sand and gravel with good surface water drainage'. (MANDATORY)

Passive Soil Reaction per Unit Depth The passive soil reaction per unit depth of the soil classification, eg '600'. (MANDATORY)

NOTE: Users should review the properties of soil classifications that they will use in any studies and ensure that the parameters listed in the database are consistent with the soil classifications being used for the project.

17.3 Editing Soil Classification Parameters

Scroll through the list of soil classifications until you locate the record you wish to edit. You may alter any of the parameters listed for the soil classification. Click on the *Edit* button and modify the data as required. To leave Edit mode, click on *Read Only*.

17.4 Deleting a Soil Classification

Scroll through the list of soil classifications until you locate the record you wish to delete. Click on the *Edit* button, then the *Delete* button to delete the soil classification currently being displayed from the database. To leave Edit mode, click on *Read Only*.

17.5 Adding a Soil Classification

Click on the *Edit* button, then the *Add* button to add a new soil classification. A blank template will appear.

Enter the various parameters, as described above, including an identifying code for the soil classification. Some fields are mandatory, as indicated above; others are optional. Click on *Update* to save the new soil classification. When entering a new soil classification, it is recommended that you have all the necessary soil classification data from the relevant standard or power authority on hand.

To leave Edit mode, click on *Read Only*.

Section 18

11 Using Poles 'n' Wires for limit state design

Version 6.0 of Poles 'n' Wires has 2 modules that can calculate according to Limit State principles, the tipload module and the pole strength module. These modules will give results consistent with the relevant sections of AS7000.

Modules are available for both the existing working stress approach and the new limit state approach so you are still able to calculate to working stress.

This is an overview of the new modules. These instructions assume you are already familiar with the working stress tipload and pole strength modules. See the relevant chapters in the Poles 'n' Wires manual if necessary.

11.1 Tip load module

The limit state tipload module is accessible through the main window or from the right click menu when in Profiler (right click on pole>calculate tipload (limit state).

You will need to set up the options and structures database before you can use the module.

Step 1: Set up the options

Option settings for the limit state tipload module are accessed through the Options menu in the tipload module. (All other settings are accessed through the existing Options function in the main program).

Options are divided into the load factors and wind loads. Go through all settings you will be using and adjust the default values to suit. Then click SAVE. Settings are not saved until you click Save.

Notes:

1. Named load conditions are as given in AS7000. You can use the "custom" setting of each load component to create your own loading condition.

2. *All non-zero load factors are applied to each calculation*. If there is a load condition you do *not* want included in a calculation, you would need to set the corresponding load factor to zero

3. Values for Q in options are in kilograms. If you have a maintenance load in kN you will need to convert to kg before saving a value for Q in options. The formula is
$xkN = \frac{x}{9.80665} \times 1000kg$

Step 2: Structures

The working stress version of tipload module allows you to manually enter a pole height, etc. Because limit state requires a comparison between pole strength and tipload, you now need to enter any poles you want to use into the Structures database *before* you can use them in LS tipload. You do this through the database menu on the main window.

Note:

The component strength Rn used in the limit state tipload module is entered as the "Wind 2" tipload and download values in the database.

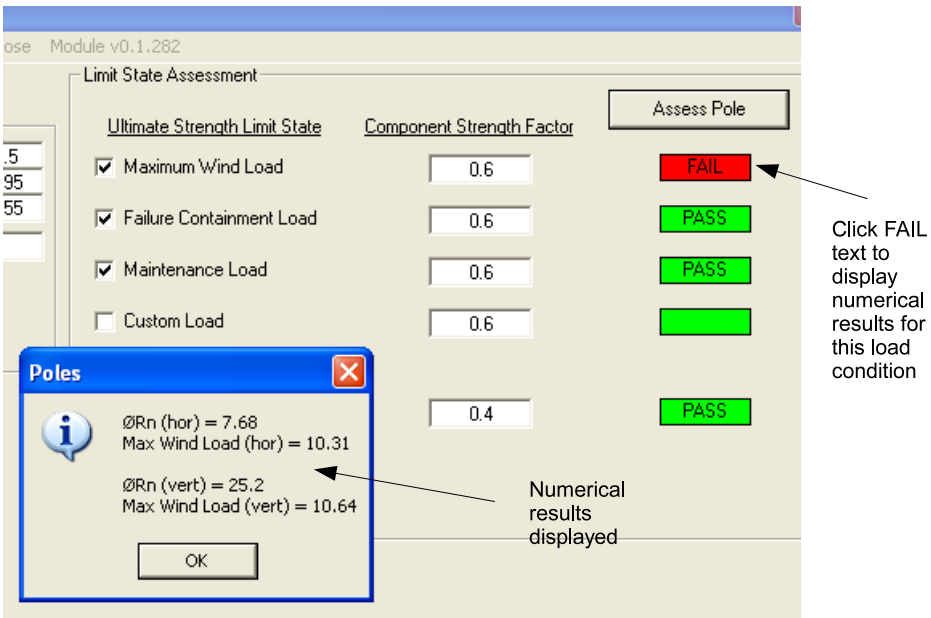
Step 3: Create a new project

1. complete the Pole Details. Select a Structure and preservation type
2. enter circuits. Note the sag tension window has changed. Enter details and then CALCULATE. Then RETURN
3. select the desired load conditions to assess. The Component Strength Factor defaults to the option settings, which by default are set to AS7000 values. These can be individually altered if required. For example, Energy Australia specifies 0.34 for wood poles preserved by full length treatment for serviceability limit state, whereas AS7000 says 0.4
4. click ASSESS

Step 4: Results

Results are displayed as PASS or FAIL. A numerical result is available by clicking on the PASS/FAIL text (see screen shot below).

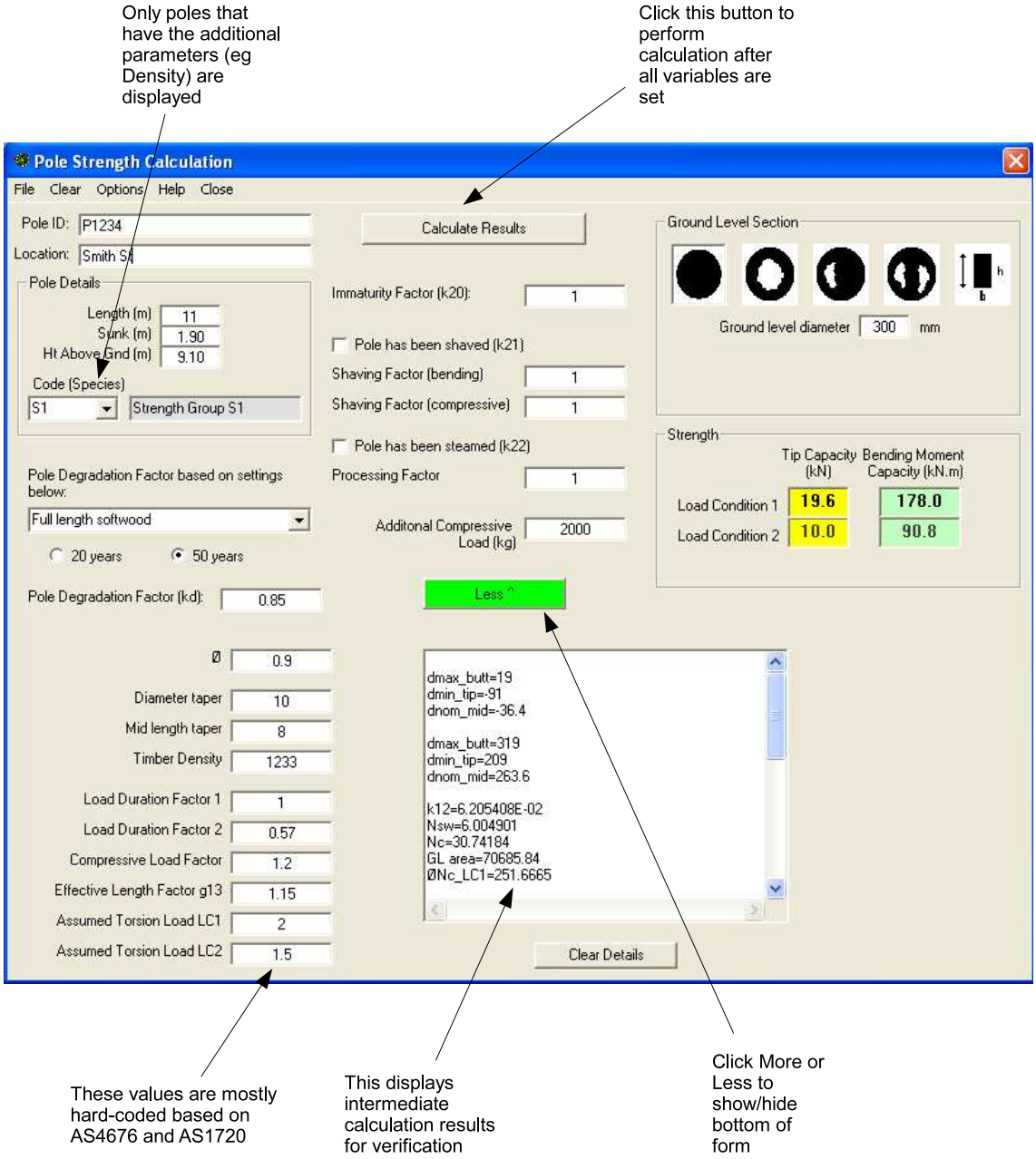
A full report (including numerical values) is available as a PDF file by clicking the PRINT button.



General Notes

1. tipload project files created by the limit state tipload module cannot be opened by the working stress module. However files created by the working stress module can be opened by the limit state module. If a pole structure is not specified in the file, you will see a message asking you to select a structure.
2. for the failure load condition, the full number of conductors is used in calculation of Wn (side force on wind span of conductors.)

11.2 Pole strength module



1. Enter or edit variables or make selections from drop-downs
2. Variables are derived from the drop-downs, radio button or tick boxes but if over-written in the textboxes the new values will be used
3. Click CALCULATE button
4. you can select an appropriate cross-section. However, the calculation method in AS7000 is really only applicable to new poles (ie solid cross-section)
5. Print a report PDF from FILE>PRINT
6. Poles database is under FILE>DATABASES on the main PnW window

Notes:

1. the default values in the Poles database for timber density are the average of values in Table1 of AS1720.2-2006

2. values for design factors are given in Appendix F of AS7000 or in AS1720.1

11.3 Foundation calculations

The Foundation Capacity calculator in Poles 'n' Wires is based on the formula in C(b)1 1991. The draft of the Handbook to accompany AS7000, section 9, indicates this is a suitable method for distribution poles.

Energy Networks Association provides a free software tool to perform foundation calculations using the Brinch-Hansen method. This tool is available for free download from the Downloads page on our website http://ipowermation.com. PowerMation does not provide any support in the use of this tool. There is documentation accompanying the software.

Section 19

1X Analysing Two Stays

This add-on to Poles 'n' Wires allows you to calculate the effect of two stays on the tip-load of a distribution pole, the load in the stays, and the vertical load on the pole due to the stays.

1.1 How to use

1. Create the tipload project in the normal way but do not enter any stays
2. Note the resultant tipload for each load condition (eg no wind, wind1 or each load condition in the limit state module)
3. Open the multiple stays module (main window>add-ons menu item)

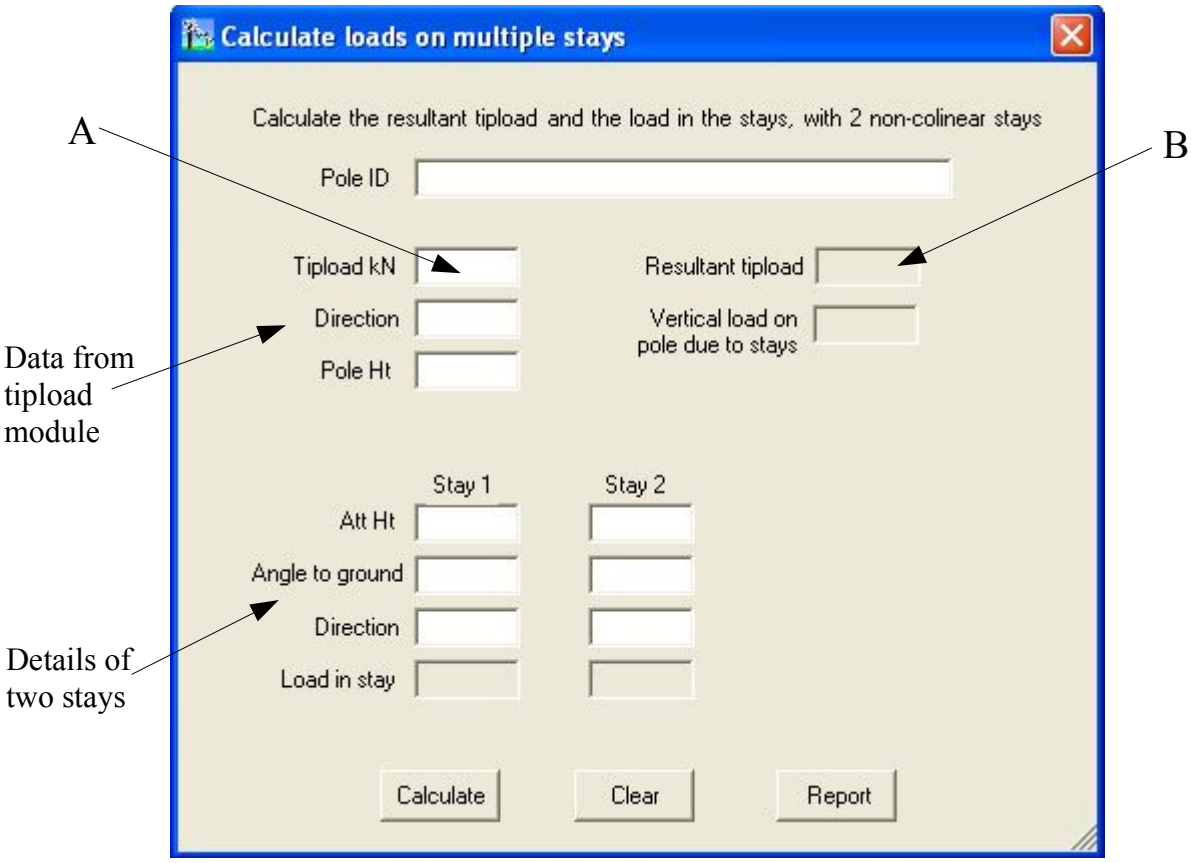


Figure 1: Multiple stays module

4. Enter data from the tipload module for a load/wind condition and the details of the two stays.
5. Click CALCULATE to obtain the resultant tipload, vertical load on pole due to the

stays and the load within the stay wires

6. Click REPORT to copy to the Clipboard a screen capture you can then paste into another document.
7. Repeat steps 6 and 7 for each load condition

1.2 Incorporating the results into the tipload module

1.2.1 Resultant tipload is zero

If the resultant tipload is zero it means the two stays are effective in balancing out the tipload. So you can add a stay to the tipload project 180º away from the direction of the tipload. This will model the two stays correctly *for that wind load*.

1.2.2 Resultant tipload is non-zero

In this case the two stays do not balance out the tipload. This can be modelled in the tipload module by adding a "plant" item representing the effect of the stays. Use the "nominated load/direction" option.

The direction will be 180º away from the direction of the tipload. The nominated load will be tipload (A in figure 1) minus resultant tipload (B in figure 1). Again, this modelling will only be correct *for the wind load you have just analysed*. You need to assess each load condition separately.

Section 20

~~7~~ XX Creating the groundline from imported data

Data representing the groundline will generally be in one of three formats:

- chainage and level
- easting, northing and elevation
- distance, bearing and inclination

The importing tools in Poles 'n' Wires allow you to create a file of groundline data and then load that file directly into the Profiler. What you are able to do with your data will depend upon how you obtain it and what format it comes in. Table 1 is a summary of common data sources and ways you can import it into the Profiler.

Type of data	Ways to enter data into the Profiler			
	Manual entry	text file	spreadsheet	DXF file
chainage, level from manual survey	✓	✓	✓	
distance, bearing, inclination from manual survey	(✓)	✓	✓	
easting, northing, elevation from survey equipment		✓	✓	✓
long section from survey drawing				✓
pole information with the groundline		✓	✓	✓

Table 7.1: Importing formats

The key to successfully importing data into the profiler is to format the importing file correctly.

7.1 Steps to importing data

1. collate the raw data
2. determine the most suitable importing format for the data you have
3. reformat the raw data as necessary and generate the import file
4. import it into the profiler

7.2 File format descriptions

The Profiler can import the three types of ground line data through various file formats. Following is a list of the standard options available with Poles 'n' Wires with a description of how to format each file correctly and a screen shot of an example file.

7.2.1 Chainage and level - text file

- each pairs of data points (chainage, level) is on a line by itself, separated by comma or tab
- all data is taken relative to chainage 0 and level 0, so for example if your first point is chainage 300, level 52, that is where it will be drawn in in the profile.

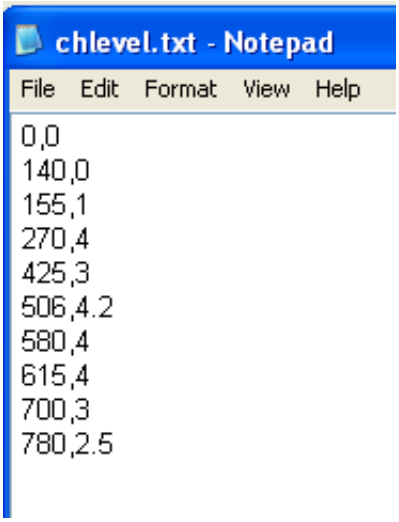


Figure 7.1: Chainage/level file

7.2.2 Chainage and level - DXF file (long section)

A long section is really a chainage and level type file. If you have obtained a long section from a surveyor you can import it into the Profiler.

General Points

- save in the oldest version DXF available to assist compatibility
- you need to know what the scaling is, horizontally and vertically
- the first point of the groundline you create in the file is taken to be chainage 0, level 0 in the profile

Ground line

- groundline data must be on a layer by itself
- only lines and polylines are processed; best to have the groundline drawn as one polyline

Poles

- poles can be drawn on a separate layer
- the distance between bottom and top of a vertical line is taken as the pole height above ground, scaled suitably
- X coordinate is taken as chainage
- text drawn at the same insertion point as the pole “base” is taken as pole ID, otherwise an “auto” ID is given

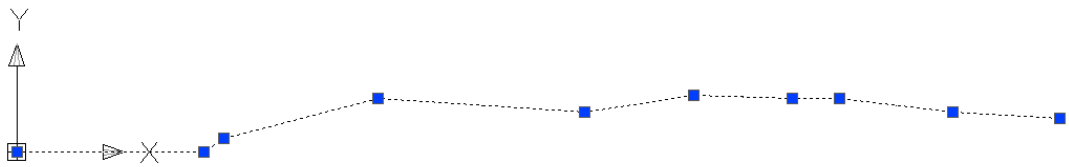


Figure 7.2: Long section as one polyline

7.2.3 Easting, northing, elevation - excel file

- The first three columns are required - easting, northing, elevation
- optional columns follow - pole ID, height above ground, pole length, sinking depth
- other information can go in the pole ID column, for example a note about a fence or creek crossing. If the pole ID column has an entry but there is no corresponding pole length data, the text in the pole ID column is placed as a note below the ground line at that chainage
- make row 1 of the spreadsheet the column headers. Correct format is shown in figure 7.3
- it is important to ensure only data is present in the sheet. For example if there is a formatted cell further down the sheet you will get an error when you attempt to import the file

	A	B	C	D	E	F	G
1	easting	northing	elevation	pole ID	height	length	sinking
2	2838858.46	6214040.29	329.92	143411	10.4	12.50	2.1
3	2839045.12	6214015.02	319.94	143410	10.4	12.50	2.1
4	2839088.58	6214007.91	314.20	130774	10.4	12.50	2.1
5	2839076.09	6213983.32	311.77				
6	2839055.89	6213946.60	309.17	143408	10.4	12.50	2.1
7	2839013.56	6213866.16	299.57				
8	2838984.12	6213810.20	299.20	143407	10.4	12.50	2.1
9	2838950.65	6213715.24	298.94	143406	10.4	12.50	2.1
10	2838959.21	6213650.35	302.70	150043	10.4	12.50	2.1
11	2838967.49	6213554.45	306.92	143404	10.4	12.50	2.1
12	2838970.53	6213530.76	306.86				
13	2838971.46	6213517.39	306.58	143403	10.4	12.50	2.1
14	2838994.07	6213498.48	306.36				
15	2839026.64	6213472.04	306.92	143402	10.4	12.50	2.1

Figure 7.3: Easting, northing, elevation - excel file

2838858.46	6214040.29	329.92	143411	10.4	12.50	2.1
2839045.12	6214015.02	319.94	143410	10.4	12.50	2.1
2839088.58	6214007.91	314.20	130774	10.4	12.50	2.1
2839076.09	6213983.32	311.77				
2839055.89	6213946.60	309.17	143408	10.4	12.50	2.1
2839013.56	6213866.16	299.57				
2838984.12	6213810.20	299.20	143407	10.4	12.50	2.1
2838950.65	6213715.24	298.94	143406	10.4	12.50	2.1
2838959.21	6213650.35	302.70	150043	10.4	12.50	2.1
2838967.49	6213554.45	306.92	143404	10.4	12.50	2.1
2838970.53	6213530.76	306.86				
2838971.46	6213517.39	306.58	143403	10.4	12.50	2.1
2838994.07	6213498.48	306.36				
2839026.64	6213472.04	306.92	143402	10.4	12.50	2.1
2839094.89	6213358.83	302.36	143401	10.4	12.50	2.1
2839236.34	6213200.70	314.80	143400	10.4	12.50	2.1

Figure 7.4: Tab delimited text file

7.2.4 Easting, northing, elevation - text file

The data described in section 7.2.3 can be saved and imported from a text file.

- Data can be separated by commas, tabs or spaces (if using spaces, make sure pole IDs have no spaces)
- there are no column headers - the first line contains data. Figure 7.4 shows the format

7.2.5 Distance, bearing, inclination - excel file

This file allows you to obtain data comprising distance along the ground, bearing horizontally (eg compass directions) and inclination vertically (with either 0 being vertically down to 180 being up, or 0 being horizontal, -90 vertically down and +90 vertically up)

You can optionally include pole details, as for all excel file import formats. Table 7.2 is an example of the correct format for the file. Figure 7.5 shows the corresponding imported profile and figure 7.6 is the planview of the same profile.

distance	bearing	inclination	pole name	height	length	depth
10	7.58	90	2098	8.84	10.6	1.76
10	7.58	90				
10	7.58	100				
10	7.58	120				
10	7.58	120				
10	7.58	110	1	8.84	10.6	1.76
10	7.58	90				
10	7.58	90				
10	7.58	80				
10	7.58	90				
10	7.58	100				
10	7.58	100				
10	7.58	100				
10	7.58	100				
5	7.58	90	5	8.84	10.6	1.76
5	7.58	90				
10	7.58	80				
10	7.58	90				
10	7.58	80				
10	7.58	90				
10	7.58	80				
10	7.58	80				
10	7.58	60				
10	7.58	60				
10	7.58	140				
10	7.58	90				
10	7.58	100				
2	7.58	90	corner	8.84	10.6	1.76
8	-298.56	100				
10	-298.56	100				
10	-298.56	100				
10	-298.56	110	txfmr	8.84	10.6	1.76

Table 7.2: Distance, bearing, inclination

Notes about the file format:

- the first three columns are required
- optional columns are from column 4 - pole ID, height above ground, pole length, sinking depth
- if the pole ID column has an entry and there is no data in the next column, it is placed as a note below the ground line
- the first row in the spreadsheet is to be column headers, as shown in Table 7.2
- Poles are inserted at the *end* of the groundline segment. If you want to start the profile with a pole you will need to enter a short non-zero length ground segment to "hold" the pole details. The first row of the spreadsheet in Table 7.2 means Pole 2098 will be at chainage 10, at the *end* of the first ground segment. Table 7.3 shows how to position the pole at the beginning of the profile, by using a short non-zero ground segment, and adjusting the second segment to correspond.

distance	bearing	inclination	pole name	height	length	depth
0.01	7.58	90	2098	8.84	10.6	1.76
9.99	7.58	90				
10	7.58	90				
10	7.58	100				

Table 7.3: Pole at beginning of the first segment

Figure 7.5: Distance, bearing, inclination imported profile

- Close the excel file in Excel or Openoffice before attempting to import it into the Profiler, or you will get an error.

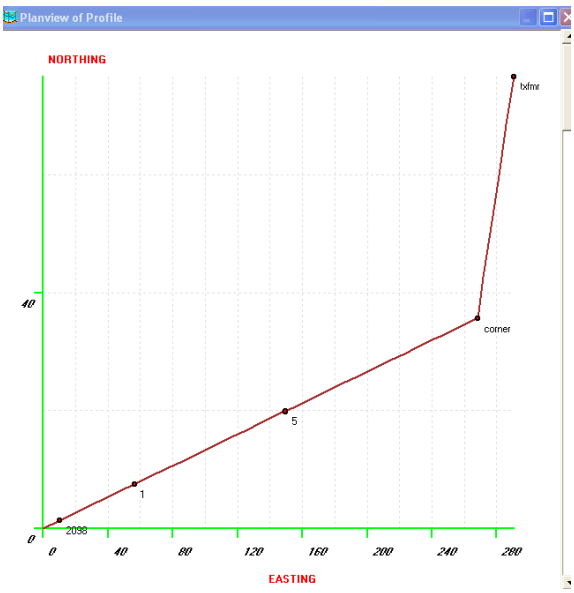


Figure 7.6: Distance, bearing, inclination planview